INTER AVIA

Review of World Aviation

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The Big Four... ?

C. G. Grey : The British Aircraft Industry (A. V. Roe & Co., Ltd.)

Transport Battles with the Sahara — Paris Salon in Retrospect

Kellett XH-10 Helicopter — 109-718 Rocket Power Unit – Convair 7002 — Jato Junior

Composite Aircraft — E. Saenger : The Laws of Motion in Space Travel

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VOLUME IV No 7 JULY, 1949

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OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F. A. I.)

Volume IV — July, 1949 — No. 7

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Front cover:

C.L. (Kelly) Johnson, Chief Research Engineer, Lockheed Aircraft Corp., personally supervises the readying of the USAF's newest jet fighter, the Lockheed XF-90 (see page 433).

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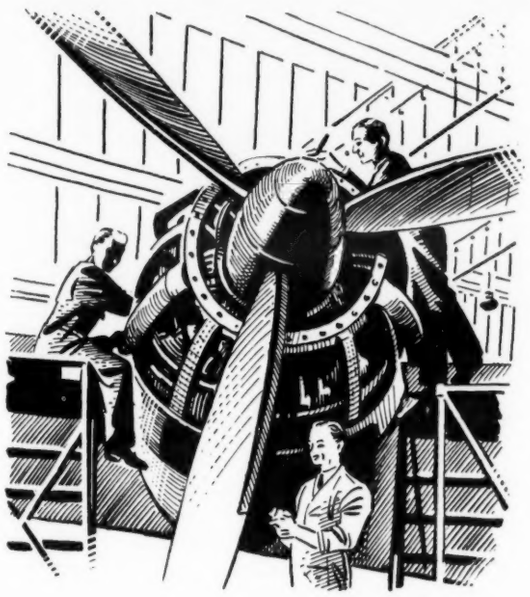

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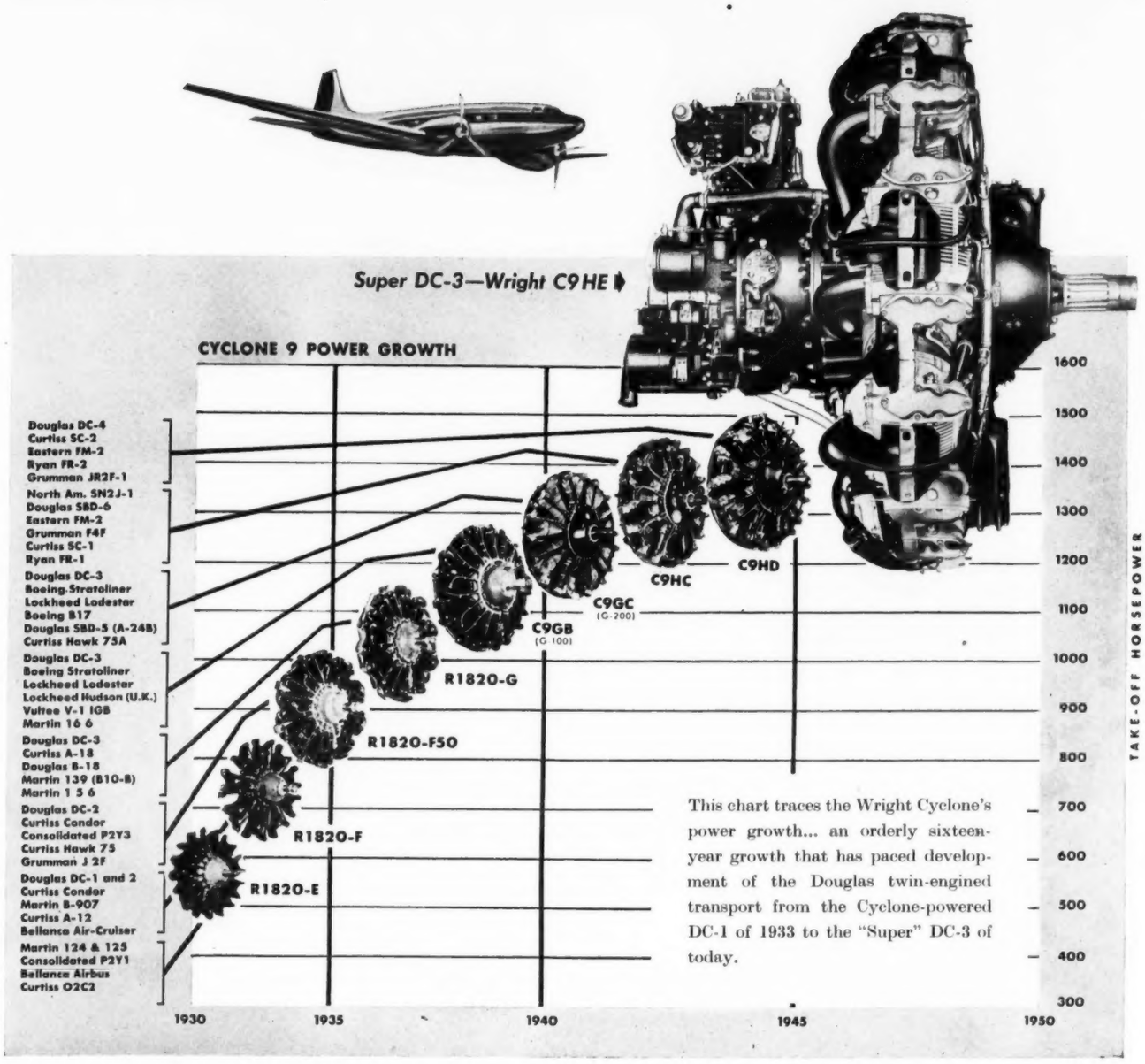

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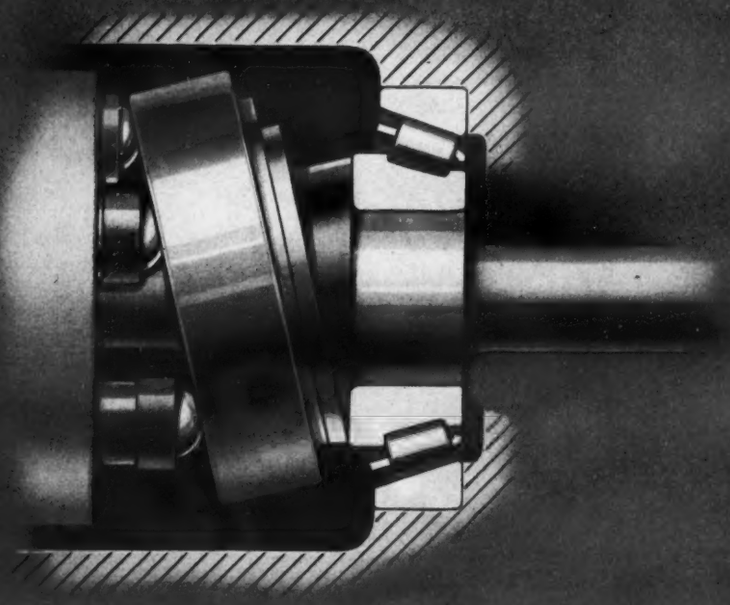

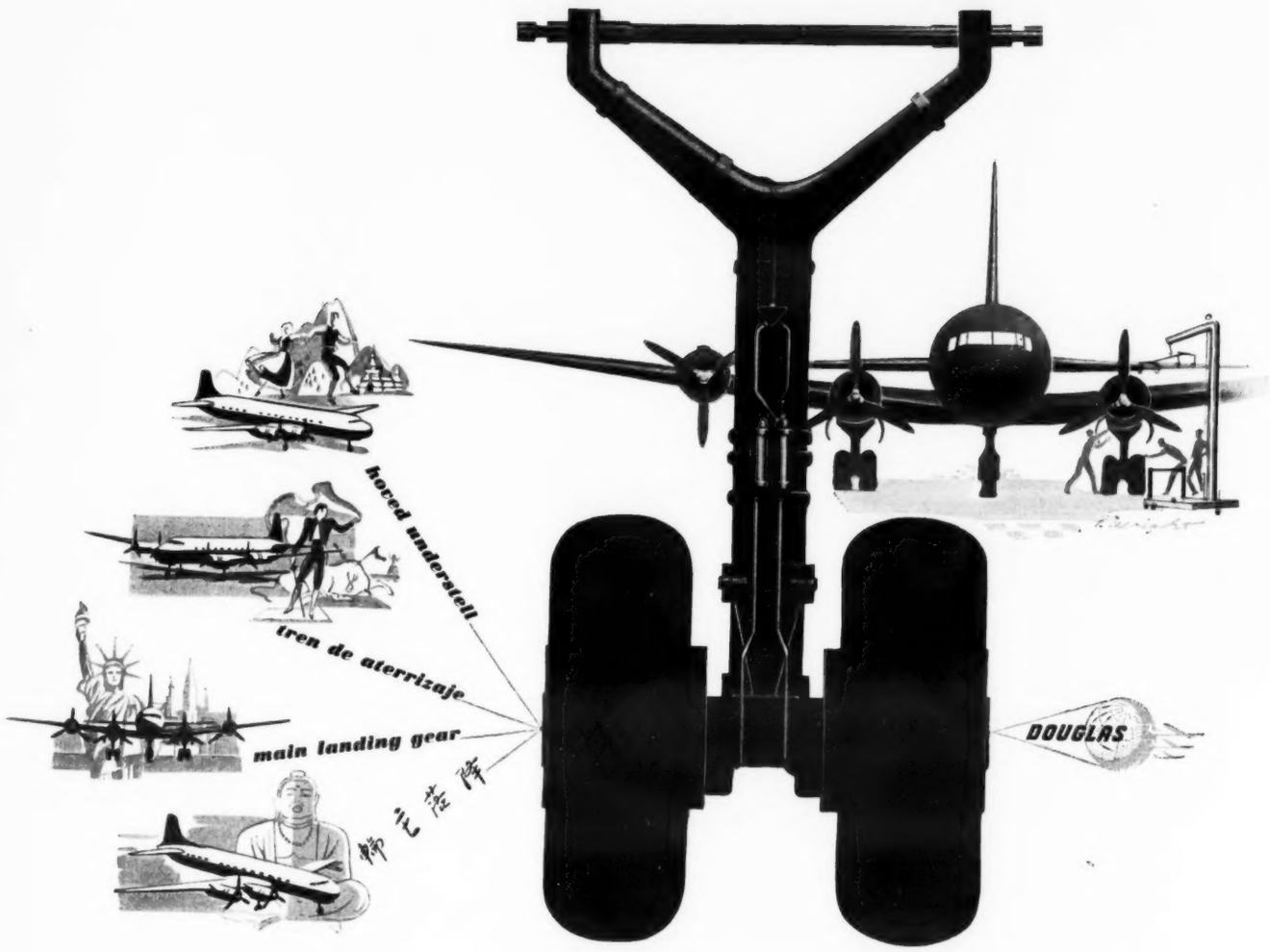

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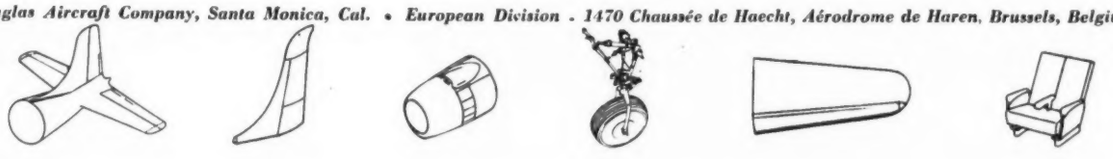

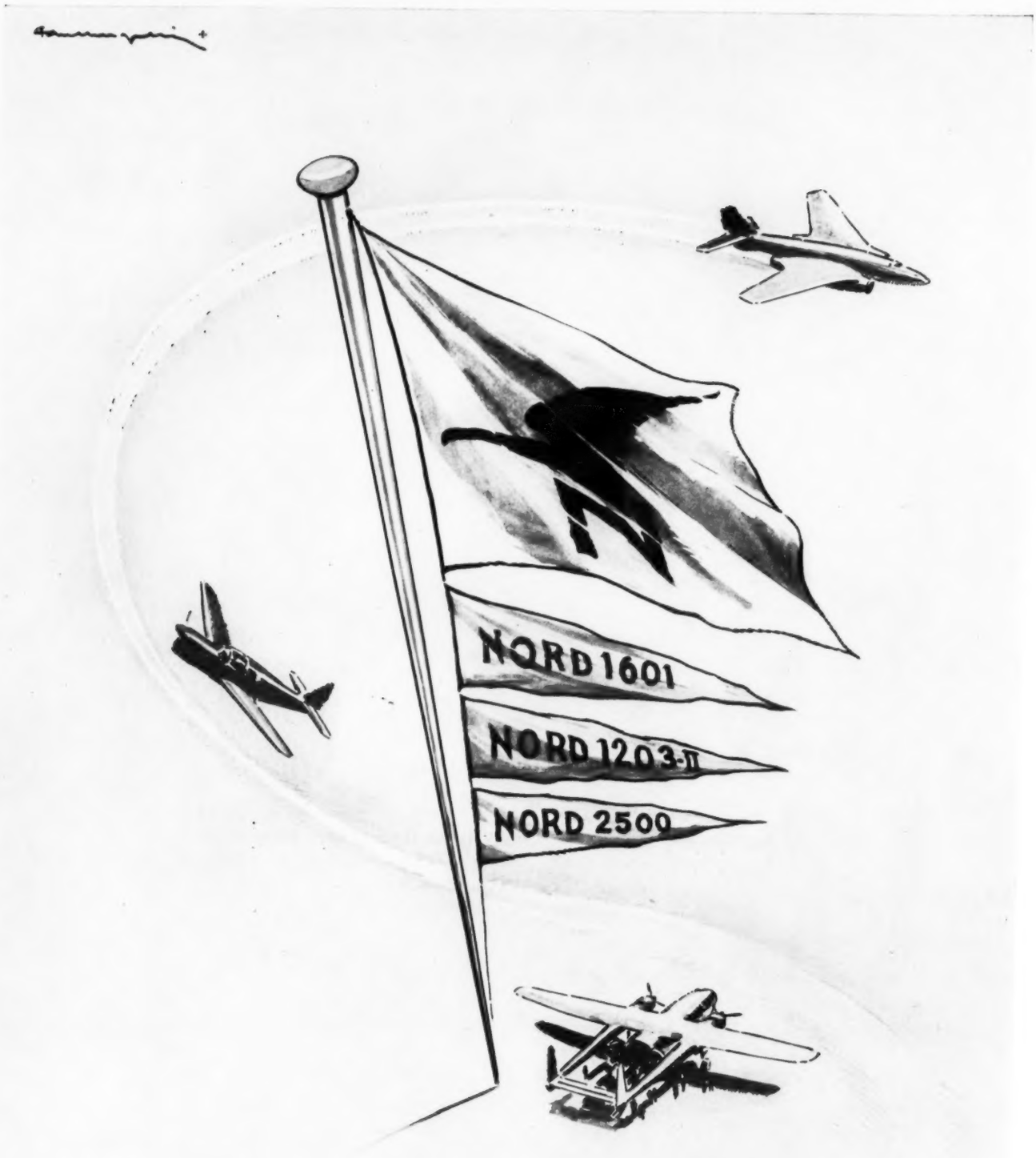

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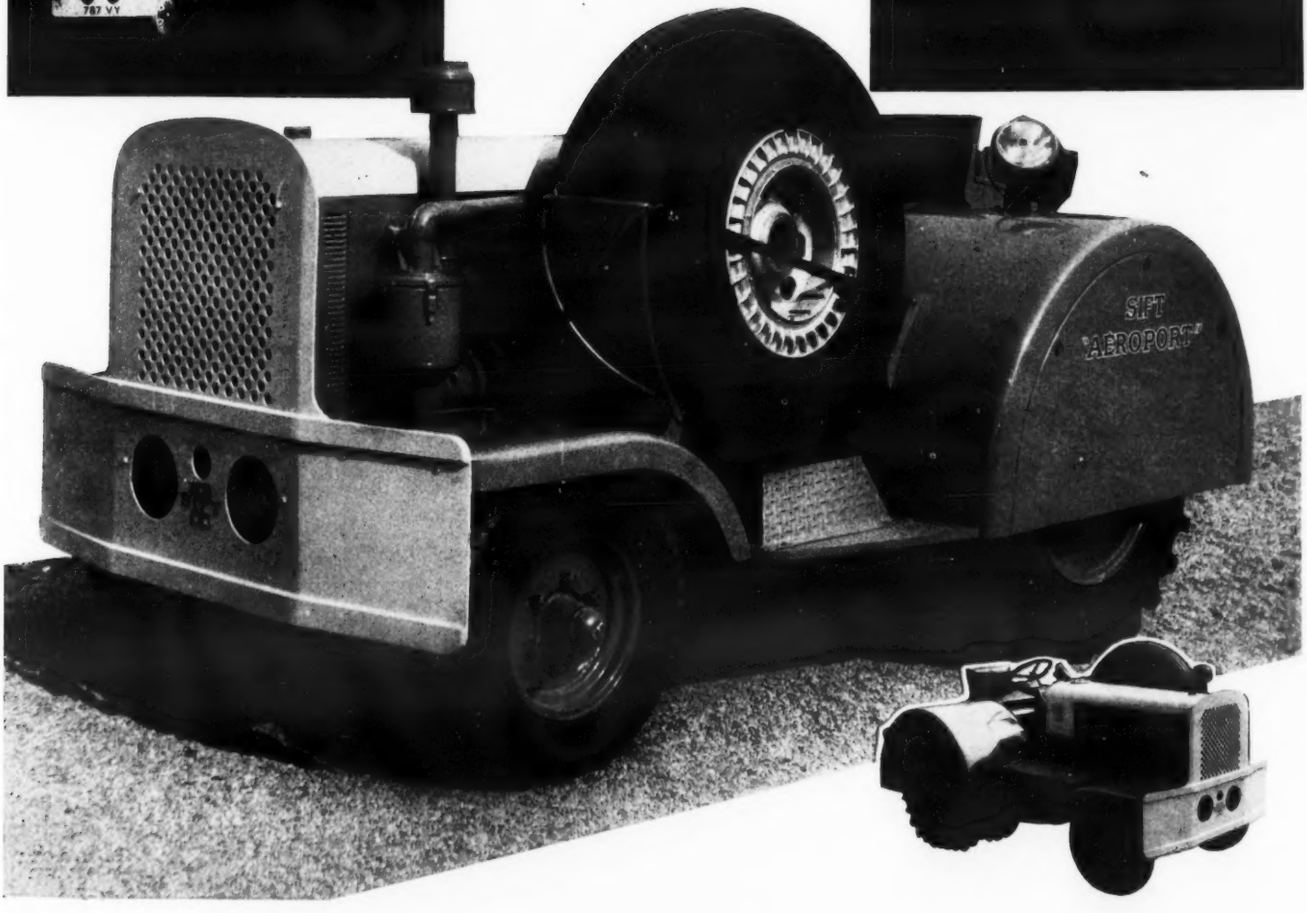

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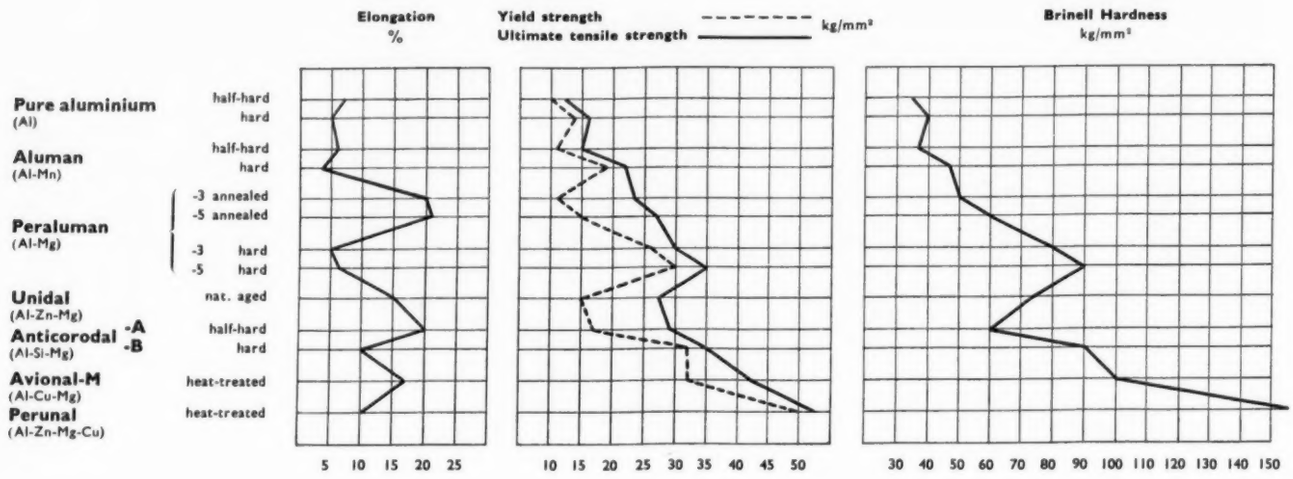

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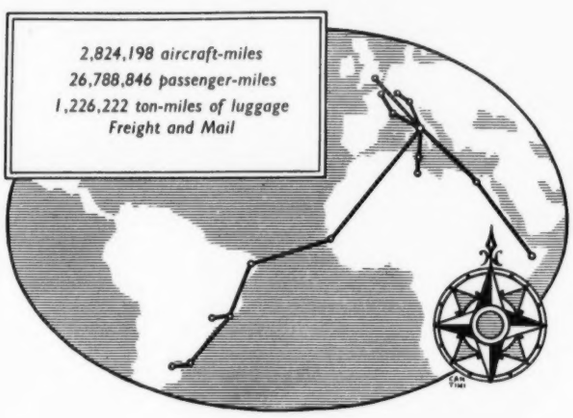

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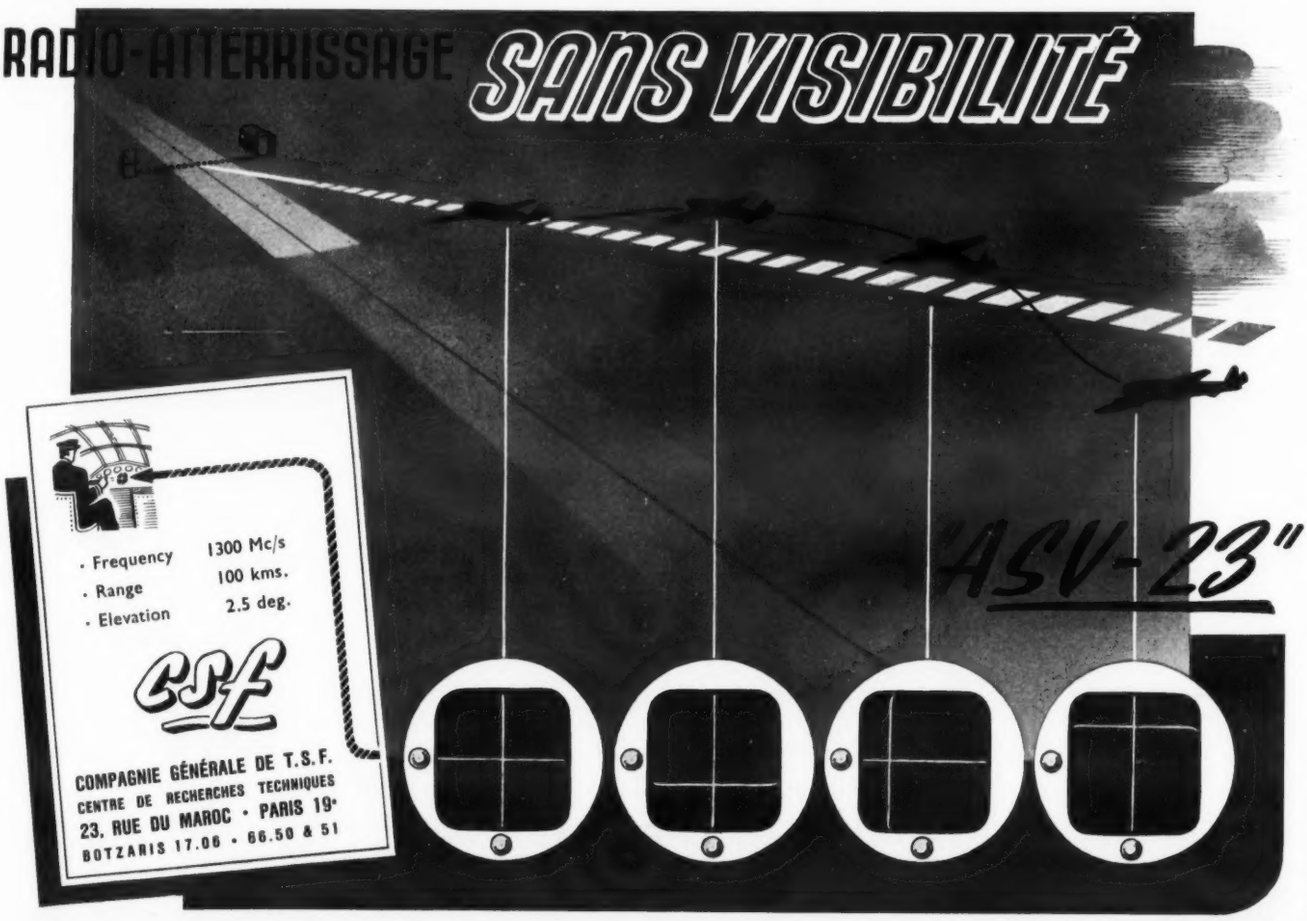

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A few weeks ago Russia's Malik and America's Jessup agreed to bring the Berlin blockade to an end and seek a *modus vivendi* between the East and the West. At the time of writing, the Big Four foreign ministers are in Paris, exchanging confidential viewpoints in the "Palais Rose"—an odd contrast, for this building, though known to the French as the Palais Talleyrand, was built with the New World millions of Anna Gould. And while all this is going on, the Western press is busily publishing statements on Russia's armament potential. In the U.S.A. there is some controversy as to whether the B-36 wonder bomber is good business for its manufacturer only, or also for the American people. A foremost English military writer lately placed Britain's armed forces under the magnifying glass. A short while ago, the Paris Salon closed its portals, and the French are hoping that business, including aviation, is once again about to take an upward trend.

These are a few of the latest happenings in the world. Let us begin with the last mentioned one.

The Paris Air Show

Two weeks, and it was over; in the form it has hitherto had, likely for always . . .

Granted, some two hundred stands were provided; by the French, British, Americans, Italians, Dutch, Swiss, and even the Turks. But that certain atmosphere, that ambiance to attract the crowds, which characterised the previous exhibitions, was absent this time. Why?

The root of the matter is—paradoxical as it may sound—that the world has become truly airminded. Today's generation knows quite well what an aeroplane looks like; tomorrow's generation knows more. An aircraft show is not a motorcar show, and whilst every third, fourth or tenth visitor may be the owner of a motorcar, it does not mean that every twentieth, fiftieth or hundredth is necessarily an aircraft customer. We haven't yet reached that stage.

Why, therefore, should the man-in-the-street spend his weekend in a building which has somehow never managed to rid itself of the dust from the Paris World Fair of 1900? He preferred to visit the countryside or one of the city's sports stadiums. He was aware that modern big airliners cannot be shown in exhibition halls. So there was not even that attraction. The aeronauts and the young people no longer find it interesting to view aircraft on the ground; they want to admire or criticise them in their proper element—in the air.

Now, the conclusion to this year's Paris Salon was in the shape of two days of aerial demonstrations at Orly Airport. And the visitors made a multitude—laymen and professionals! They saw British and American types; they also saw that the French prototypes, which have been like something stored away in the cupboard for another day, were altogether airworthy.

Let us sum up this year's Paris Salon. The French aircraft industry seems to have arisen from its sick-bed, and the healing process is progressing satisfactorily. Admittedly, France may not become a first-class air power between today and tomorrow. But it should not be long before her national factories start turning out aircraft for the protection of her frontiers and for assuring European inland air services. The demonstration of French long-range airliners was impressive but, for the time being, it was only in the nature of a promise.

Such was the satisfied feeling with which the Orly visitor was able to return home. And such is the sum total of the 1949 Paris show.

International exhibitions in the Grand Palais belong to yesterday. But international aerial demonstrations at Orly—or any other Paris airport—should henceforth be the aim of the French Syndicate of Aeronautical Manufacturers. If this course is pursued, then Paris will continue to be the annual, or biennial, meeting place of the world's aeronauts and all those who believe in aviation.

Britain's defence

Contrary to the preceding Paris Salon of 1946, this year's show was not so strongly dominated by the British products. Not that these shone any the less brightly. Firms such as the Bristol Aeroplane Co. and Vickers-Armstrongs, and a number of accessories manufacturing concerns, provided truly impressive stands. And at Orly the visitors could only gape at the imposing fly-past of Hawker's newest high-speed experimental aircraft, and general attention was commanded by the demonstrations of the Westland-Sikorsky and Bristol 171 helicopters, as well as the proven Bristol 170 all-purpose transport. But what people did not see were Britain's four trumps, one of which, in fact, has not yet been played. Only high above their heads were they able to see the D.H. "Vampires," until further notice the standard fighter equipment of Western Europe's air forces and, according to Ministerial statements, France's main fighter until she can produce her own. But they saw nothing at all of the newer Rolls-Royce turbo engines, although these have up to the present unlikely been surpassed in quality. Nor did visitors to Paris see the Vickers "Viscount," the new turbo-prop airliner which should remove any public misapprehension about the "Viking" manufacturers' reputation as builders of commercial transports. The fabulous Bristol "Brabazon 1" could not be admired as it has not yet taken the air. The British nation's hopes are pinned to it. Generally speaking, however, there was ample evidence of an active British aircraft industry; firms such as Rolls-Royce and de Havilland exemplify the excellent achievements of this industry, even if, from the quantity-production standpoint, they do not yet stamp Great Britain as a big air power.

The above-outlined bright side is, however, overshadowed by a probing study which Britain's most distinguished military writer, Captain B. H. Liddell Hart, recently made of

Philip Jessup (left), head of America's U.N. delegation, and Yakov Malik, of the Soviet U.N. delegation, a typical representative of the younger Russian diplomacy. Their meeting in New York led up to the Paris conference of the Big Four Foreign Ministers.

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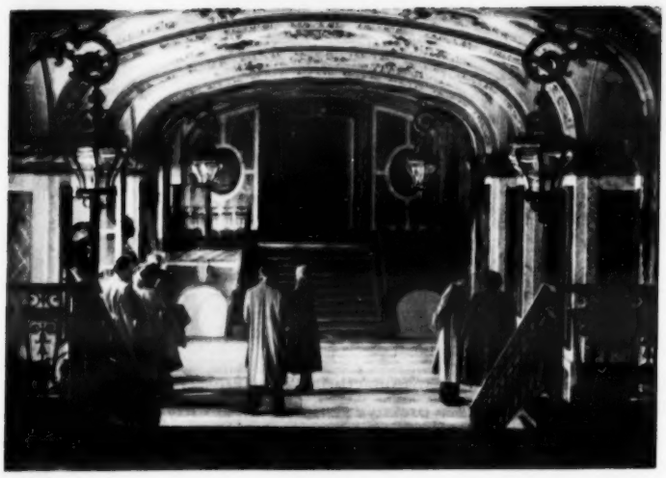


Prior to the meeting of the Council of Foreign Ministers in Paris, which is to remain closed to the public, frequent "press conferences" were given by the "lady of the manor" at the Palais Rose.

the British armed forces. Liddell Hart is an authority, and his findings cannot be ignored.

Last April Captain Hart wrote an article "by invitation," so to speak, of *Picture Post*, a leading British weekly, when he examined his country's military establishment under the title "Are we getting value for our money."—Liddell Hart says "No" . . .

Picture Post introduces the article as follows : "This is the longest article we have ever published. It is also one of the most important. Today, this country is spending around £750,000,000 a year on its armed forces, about one-fifth of our total annual expenditure. Yet, for this immense outlay, we are not providing reasonable safety for these shores —and we are not in a position to play our part in the defence of Western Europe. Why not ?"

And Liddell Hart gives the answer.

Although Britain has some 800,000 men in the forces, compared with only 450,000 in 1939, the present operational force—"the effective fighting force ready for emergencies" —is far below what it was before the outbreak of World War II.

The root of this evil is the system of conscription introduced with the National Service Act two years ago. Not only are the short-term conscripts lacking in real military value, but their mixture with long-term regulars heavily handicaps the latters' training and, consequently, combat efficiency.

Out of the last defence budget totalling £750 million (about $3,000 million), approximately £325 million were spent on the Army, £190 million on the Navy, and about £200 million on the Air Force. The result ? With conscription causing enormous proportions of this money to be spent on clothing, feeding and paying the men, leaving little for combat material, today Britain has neither a strong army—not to speak of armoured divisions—, nor the sort of navy she really needs ; the Royal Air Force is deficient in both equipment and personnel.

Liddell Hart urges the scrapping of conscription and the introduction of more attractive conditions for regulars ; his other recommendations may be summed up roughly as follows :

1. For the Army, concentration on building up a streamlined force—not mass—having speed and fighting power through better and more equipment, particularly armoured divisions.

2. For the Navy, fewer big ships and more anti-submarine vessels ; some budgetary economies in order to help to develop the R.A.F.

3. For the Royal Air Force, first of all a clarification of its responsibilities : to guard Britain against air attack, to provide air cover for the land defence of the West, to carry out a counter-offensive, and to help the Navy in covering sea-routes against a submarine offensive. A larger budget (against a smaller Naval budget) so as to be able to induce highly-skilled pilots, mechanics, etc., to stay in the service, and above all to build up a much stronger force of fighters (including night-fighters) and tactical bombers (fighter-bombers). The provision of a large strategic bomber force is too expensive for Britain and should be left to the U.S.A., which is better equipped to carry out that rôle.

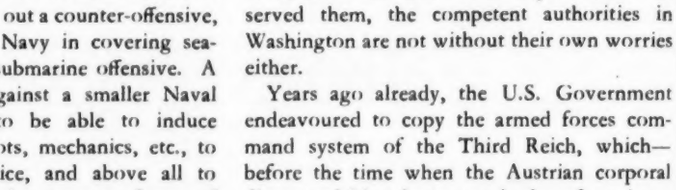
4. The present Chiefs of Staff Committee—composed of the professional heads of each of the three Services—is by nature incapable of formulating the desired clear-out decisions. What Britain needs is a man—a Supreme Chief of Staff—who can settle priorities by the needs of the case.

Meanwhile, these hard truths by Liddell Hart came at a time when the British were unchangedly tightening the belt, voluntarily rendering homage to Goddess Austerity in an effort to balance the budget. Put yourself in the place of one of the harassed British taxpayers who sees, in black on white, in one of the country's authoritive weeklies and signed by a man who knows the subject, that his government has been spending around £750 million, thus about one-fifth of the total national expenditure, to no useful purpose. The Russian General Staff ? They certainly know about it, too, though they may perhaps entertain exaggerated hopes in consequence. The allied Western European countries ? They are no longer rich in illusions. And the men in Washington ? There are still some isolationists, who fight against any U.S. showing of interest in European affairs, and who will now triumphantly brandish the fact that they haven't a first-class ally in Great Britain. Liddell Hart, however, wishes that Great Britain should become a powerful ally.

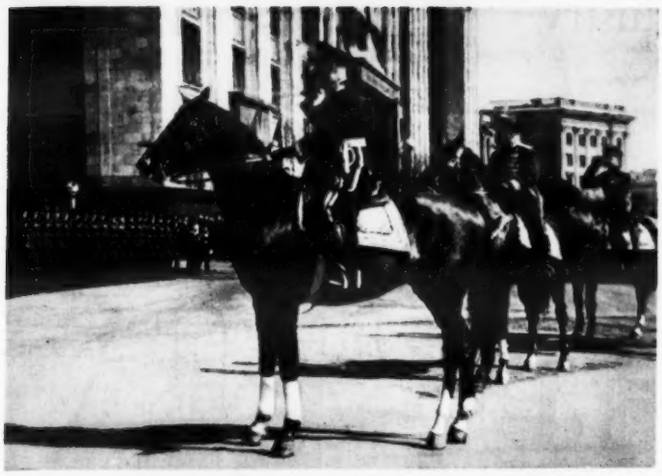
U.S. defence

Whereas the British may be finding it hard to swallow the facts which Captain Hart has served them, the competent authorities in Washington are not without their own worries either.

Years ago already, the U.S. Government endeavoured to copy the armed forces command system of the Third Reich, which—before the time when the Austrian corporal discovered his talents as a leader of armies—showed itself to be satisfactory and was, in fact, responsible for Germany's initial successes in World War II : the so-called *Oberbefehl der Wehrmacht*, a supreme command of all three armed services. The U. S. military experts were, and still are, determined to learn every-



President Vincent Auriol of France receives the Big Four Foreign Ministers (left to right) : Robert Schuman (France), Vincent Auriol, Andrei Vyshinsky (U.S.S.R.), Dean Acheson (U.S.A.), Ernest Bevin (Great Britain).



May Day parade on the Red Square in Moscow.

thing possible from this structure, whereby the idea is to give each service precisely that which its rôle calls for, but nothing more. The aim is to prevent the three services, in the event of war, from advancing and hitting separately. The late U.S. Secretary of Defence, James Forrestal, laid—as well as his severely spent forces allowed him—the foundations for such a structure. His successor, Colonel Louis E. Johnson, has the job of finally hatching the plan.

Thus, Defence Secretary Johnson took his place at the helm a few weeks ago. His first deeds were as surprising as they were energetic. He seems to have done little to alter the structure of the Army, presumably because there was no great reason to touch it. Men such as George C. Marshall, Dwight D. Eisenhower and Omar Bradley have apparently taken good care that America's infantry divisions and armoured formations should represent a *non plus ultra*.

Meanwhile, two world wars have unavoidably transformed the U.S.A. from a continental into an intercontinental power. An army, however good it is, can only operate intercontinentally if suitable overseas communications are assured. In simple language, therefore, our generation is faced with the question: Is it best to assure these communications with the navy, with the air force, or with a combination of both? It was difficult for the Americans to give an answer, since their country now has the strongest navy as well as the strongest air force, and because the top men of these two services are fighting between themselves for every inch of competency they can gain in favour of their own branch.

Colonel Johnson has decided the outcome of this long struggle; for the present in favour of the U.S. Air Force. He abruptly cancelled the Navy's hopes with respect to the 65,000-ton super-carrier, robbed it of certain illusions regarding a strong air arm of its own, and he nourished all kinds of illusions entertained by the Air Force.

Some members of his staff and general entourage apparently convinced him that there existed a certain American bomber which was absolutely pre-destined for intercontinental warfare requirements; that the latest U.S. fighters were powerless against this bomber, and enemy fighters consequently even more so, this because of the new aircraft's ceiling and speed; and, moreover, that it possessed a range which could decisively weaken any presumptive enemy. In short, therefore, a wonder weapon! We refer to the Consolidated Vultee B-36 six-engined long-range very-heavy bomber, which from one day to the other was put into quantity production and, thereby, just as suddenly caused production plans for other bombers and fighters to be cancelled.

That was roughly the situation when, at the beginning of last May, the disfavoured Navy, the disfavoured aircraft manufacturers, and certain members of the U.S. public began raising their voices against this "Super Douhetism" of Johnson, which they denounced as far too unorthodox, risky, and possibly fatal to U.S. defence. The Senate ordered the B-36 miracle bomber to be X-rayed and ausculted in every possible way, by staging mock attacks against it with Navy and Air Force fighter aircraft.

As all this concerns a several billion dollar programme, the U.S. public also is very much interested. Of a total national expenditure around $42,000 million, nearly $16,000 million, thus almost 40 per cent., has been allocated for defence; and of this, almost a third goes to the U.S. Air Force.

Russia's defence

If, in speaking of Russia's defence, one wishes to be factual, one should not forget that, in this matter, the wisest of wise men have erred at all times—from Czarist days to modern times. Let us, therefore, proceed with caution.

To speak in figures, nevertheless, the Soviet defence budget for the current year is officially given as 79,000 million rubles, about 20 per cent. of the national revenue; at the exchange rate of 8.5 rubles equal to $1, this works out at about $9,300 million. Now, many a Russian defence item figures on the budgetary books of other domains of national expenditure, so that we might fancifully imagine an effective defence budget of 180,000 million rubles, thus nearly 50 per cent. of the Soviet national income of 400,000 million rubles. The truth is probably around half this figure, as the Soviet Union, too, has to undertake something in order to rehabilitate the country and raise the nation's standard of living.

The peace-time military establishment of Russia is estimated at about four million men (it was about 1½ million under the Czar), of which approximately 2½ million form the Army, the remainder being divided about equally between the Navy and Air Force.

It seems superfluous to speak of the Russian Navy, as even if the Soviets possess a strong submarine force, the lack of natural bases and the possibility of blockade measures make Russian sea power such that it should not be overestimated.

Conversely, the value of the Red Army—in infantry divisions and armoured formations—should by no means be underestimated, for in this structure lie the roots of the Russian resistance, Russia's final victory, and the basis of the entire Soviet doctrine. Perhaps Russia does indeed possess fifty armoured divisions; against them, meanwhile—and we can be sure about this—Western Europe, including Great Britain, is incapable of showing any effective resistance.

And the Soviet Air Force? Reportedly 1,600 four-engined bombers, of a design which must strike a familiar note with the B-29's begetters; doubtlessly a good number of jet fighters, for whose development German engineers were in no small way responsible; numerous paratroop formations and certainly an imposing array of guided-missile designs.

In quantity and quality, Air Power No. 2, on the heels of Uncle Sam.

At the "Palais Rose" in Paris

At the time of writing, four foreign ministers are in conference in the so-called "Palais Rose," the pink-marble mansion on the Avenue Foch, near the Bois de Boulogne. On the one side there is Andrei Vyshinsky, of Russia; on the other side are Dean Acheson, Ernest Bevin and Robert Schuman, respectively of the U.S.A., Britain and France. They have to deal with a few matters which a suddenly-ended world war left unsettled.

Their meeting represents the Council of Foreign Ministers, but—speaking in a manner more generally understandable—this meeting is in the nature of a tug-of-war. Mr. Vyshinsky is pulling on one end of the rope, the Acheson-Bevin-Schuman team is pulling on the other. Even to the least athletic of observers, it must seem puzzling that a three-man team cannot, at the first tug, beat a solitary opponent . . . if the three are really the Big Three.

The Big Four? Are they not two-and-a-half for the present?

E. E. H.

The British Aircraft Industry

BY C. G. GREY, LONDON. (PART II)

A. V, Roe & Co., Ltd.

A. V. Roe & Co., Ltd., of Manchester, is, I believe, the biggest unit in the Hawker-Siddeley combine. At any rate the output, in value of "Ansons" and "Lancasters," "Manchesters" and "Yorks," during the 1939-1946 war was almost certainly greater than of any other of the combined firms, allowing that other firms outside the combine made "Lancasters" under the orders of the former Ministry of Aircraft Production.

The originator of the firm, Alliott Verdon Roe, was an adventurous young man. He lived a rough life in Canada, went to sea as an engineer and donkey-man (on the donkey-engine) in a tramp steamer. Then he became fascinated with the idea of flying and took to making models of what he thought aeroplanes should be. That was in 1906-1907. He worked as an engineer, made some money and spent it making models as long as it lasted. Then he earned some more money.

His father was a doctor in Manchester. His mother, a Miss Verdon, was a brilliant organiser. All the sons bore her name. Hence the "V" in Avro. A. V. Roe built a big machine with an engine and made it hop off Brooklands racing track in 1908, but it did not fly under proper control. After Brooklands cast him forth, he went to Lea Marshes in East London, built a triplane (illustrated) under some railway arches, fitted it with a J.A.P. motorcycle engine, and really flew in it. In 1910 he rented a shed at Brooklands and built several biplanes, with 50-H.P. Gnome and with Green water-cooled engines.

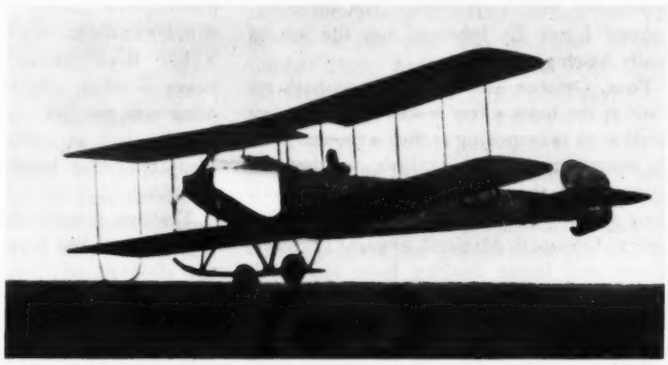
From 1909 he had been helped financially by his younger brother, Humphrey Verdon Roe, who had been an officer in the Manchester Regiment in the siege of Ladysmith (South Africa) and now owned a factory in Manchester where he made "Bull's Eye" braces. Hence the jest that the early Avro aeroplanes were kept in the air by Bull's Eye braces.

A. V. Roe & Co., Ltd., was registered as a limited company by H. V. Roe and A. V. Roe in 1910, and succeeded from the start. H. V. was the business head and A. V. was the engineer-designer. As Works Manager at Manchester they had R. J. Parrott, a first-class man, who died only a few years ago. And in charge of the Drawing Office they had Roy Chadwick, who was killed in 1948 in one of those stupid accidents such as have killed so many good men—the aileron controls of a "Tudor" were crossed, and the aircraft turned over as the pilot, "Bill" Thorne, who was also killed, tried to take it off.

Among the youngsters in the works was Roy Dobson, who helped to tune up the Avros on the aerodromes. He is now Sir Roy Dobson, and head of the Avro firm, from which H. V. Roe retired to rejoin the Army in 1917, and A. V. Roe retired in 1929, when he was knighted, to found Saunders-Roe Ltd. at Cowes, who are now making the world's biggest flying-boats.

In 1912, a dozen or so of the 50-H.P. Gnome-powered Avros were ordered by the Royal Flying Corps (which had just been formed) as trainers. They were a great success ; so much so, that Chadwick continued improving the type, and in 1914, before war broke out, had produced the 504 type, which in a later model, the 504 K, became the standard trainer of the R.F.C. (Royal Flying Corps) and of the R.N.A.S. (Royal Naval Air Service) and later of the R.A.F. After the war stopped in 1918, the 504 K was adopted as a trainer by every nation which aspired to have an Air Force—except the U.S.A. and France (who built

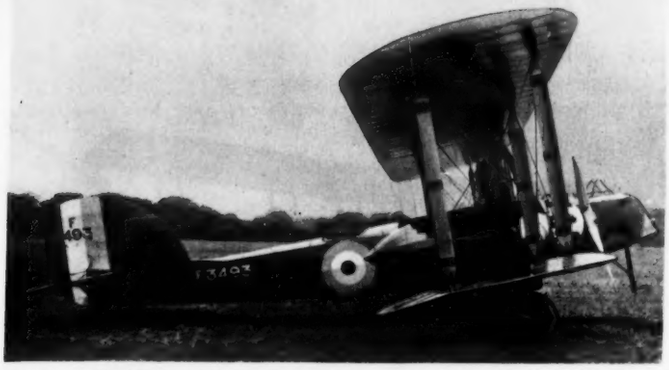
In 1908/09 A. V. Roe began with this triplane to make his reputation as an aeroplane builder. The engine, not shown in this picture, was a 9-H.P. J.A.P. motorcycle engine.



The Avro 500, powered with a 50-H.P. Gnome engine, was the first Avro ordered by the Royal Flying Corps. It was the forerunner of the famous 504 series.

The Avro 504 K, Britain's standard trainer towards the end of the 1914-18 war.

Even in 1924 the Avro 504 N (Armstrong-Siddeley "Lynx" engine) was one of the most popular trainers. A fixed engine instead of a rotary type made it a wonderful machine for stunt flying. (This one seems to be flying circles with one wheel on the ground—a stunt within the scope of the 504 N.)



The Avro "Manchester" twin-engined bomber of 1918. It had two 320-H.P. A.B.C. "Dragonfly" engines. Though the war's end prevented its quantity production, it nevertheless served as pattern for the . . .

Avro "Manchester" of 1939. Because the power system (Rolls-Royce "Vultures") was unreliable, production was soon stopped.

The Avro "Lancaster" bomber, of which the 1939 "Manchester" was the precursor, was one of the outstanding successes of the last war. (Rolls-Royce "Merlin" engines.)

The Avro "York" troop and freight carrier did plenty of good work for R.A.F. Transport Command, notably on the Berlin Airlift.

their own), and Germany, who was not allowed to have aeroplanes until years later, and by then the 504 K was out of date.

When the war ended and the aircraft trade was not too good—even for trainers the market was small—A. V. Roe & Co., Ltd., was sold to Crossley Motors Ltd., who in fact took little interest in pushing Avro interests. So, a few years later, in 1928, the firm was bought by Mr. John D. Siddeley, who already controlled Sir W. G. Armstrong-Whitworth Aircraft Ltd. and the Armstrong-Siddeley Motor Co., Ltd., which made very fine motocars, and had, during the 1914-1918 war, been brought in to make Siddeley aero engines (of which more is to be said in a later article). This Siddeley-Armstrong Whitworth-Avro combine was the big mass on which the Hawker-Siddeley combine of the present day is based. J. D. Siddeley was made a Knight in 1932 and a Baron (as Lord Kenilworth) in 1937. Of that more later.

But A. V. Roe & Co., Ltd., remained a separate entity, under the management of Roy Dobson, who had steadily worked his way from the workshop floor, as one might say, to be head of the firm. And, parallel with him, Roy Chadwick rose on the technical side as chief designer and engineer. They made an ideal combination, and manufactured an immense variety of aircraft, mostly to Air Ministry specifications.

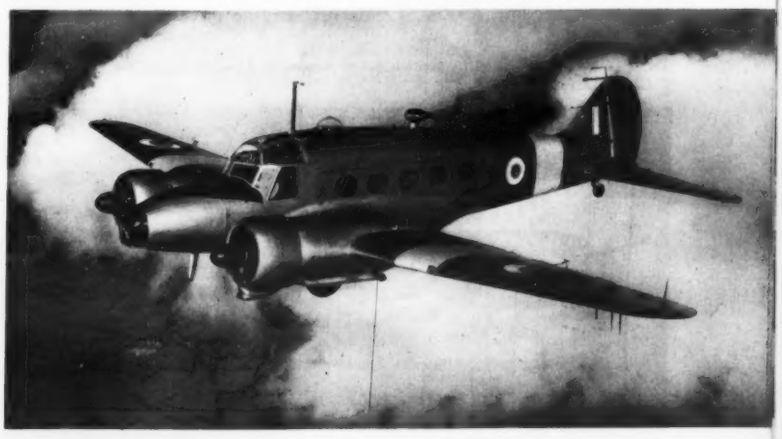
Mr. Siddeley acquired the designs of certain three-engined Fokker types, which were built by Avro. But their greatest success after the historic 504 K was the "Anson," produced in 1935. This was a small twin-engined machine which had two Armstrong-Siddeley "Cheetah" engines of 270 H.P. each. With this total of 540 H.P. it carried six or eight passengers, according to the load of fuel needed for the distance of its voyage. It was used as a commercial transport, carrying small loads of goods or a party of business men, or tourists for pleasure, or to carry five or six R.A.F. pupils who were learning navigation, or to "convert" pilots of single-engined machines to twin-engined craft such as "Beaufighters" and "Mosquitos."

As navigation trainers the pilots had great fun with them. One friend of mine said that he used to tell the pupils to set a course to a given place and fly where they told him—with curious results very often. For example, once he told the "class" to direct him to Land's End (the most western point of England) from London. But when he found himself and them over Brussels, he said he turned round and came home. They had been directing him on a "reciprocal" bearing —that is exactly the opposite line.

When war came in 1939, the "Ansons" did fine work on coastal patrols against submarines and in escorting convoys up the English Channel and the North Sea, in all weathers—fog, gales and snow. In something like four years of war, I did not hear of any life being lost by the failure of the engines or mechanism of an "Anson." And since the war many have been sold for charter work.

A new type "Anson" is now being made with "Cheetah Mark 15" engines, which makes a faster combination with greater range.

The Avro "Anson," a real handyman and one of the "great" aeroplanes of the 1939-45 war.



The Avro biplane Type G, the firm's first cabin aeroplane (1912), marked the beginning of A. V. Roe's activity in the passenger aircraft field.

The year 1920 saw the Avro 547 cabin triplane for five passengers. A.V. Roe himself is seen on the extreme right in shirtsleeves.

Before war began, Avro started work on a big bomber to be called the "Manchester," after an experimental two-engined bomber built in 1917 or so, and never produced in quantities, because that war stopped too soon. The 1939 "Manchester" was not a success, because it was fitted with two Rolls-Royce "Vulture" engines. This was an X-shaped engine made up, as one might say, of a normal "Merlin" engine, with another upside-down below it, both driving on the one crankshaft. The result was that the "Master" big end bearings gave way. We lost many "Manchester" crews, in Germany, and perhaps in the sea, from that cause. Rolls-Royce have had so many years of continual success that they can afford to admit their very few failures.

The result of the failure of the "Manchester" was that Roy Chadwick set to work to convert it into a four-engined craft, with two normal "Merlins" on each wing. This was called the "Lancaster," and was one of the outstanding successes of the war. For the last three years of war it shared all the heavy bombing with the Handley Page "Halifax" (of which more will be said in a later article).

Another of the Avro wartime products, which was built in 1942 and did great work, was the "York" troop-carrier. It had the wings and engines of a "Lancaster," and the same undercarriage (lengthened for the high wing) and the same tail surfaces. But the body is what in the U.S.A. is called a "box-car," or closed truck of a railway. It is square in cross-section and carries an immense load of freight and/or passengers.

During the war it was used to transport troops and supplies. After the war, thousands of soldiers and airmen were brought home for demobilisation in "Yorks." The percentage of accidents was very low. Later on, "Yorks" were largely used for civilian passenger and freight transportation. In that work also, they have a fine record for effectiveness and safety.

Just before the end of the fighting (or rather bombing) a modification of the "Lancaster" was produced, and called the "Lincoln." The performance of the "Lancaster" had been stepped up from time to time as succeeding marks of "Merlin" engine gave more power. At last Chadwick decided that he had enough power for a machine which might almost be called a new design—the "Lincoln" was the result, but the war stopped before it was used to any great extent.

When civil flying began, the fuselages of a number of "Lancasters" were altered to carry passengers. There was little space, so they carried only a few (eight or ten), but they carried great weights of mail and freight in the bomb bays. These machines were called "Lancastrians," and were chiefly used for high-speed mail-carrying, flying between Ceylon and West Australia non-stop across the Indian Ocean. They brought the air mail between London and Sydney down to about four days.

While the "Lancastrians" were in use, Avro produced the "Tudor" series of civil airliners. These were based on experience gathered with the "Lancasters" and "Lincolns." They had similar wings, but the fuselages, instead of being square in cross-section, were circular and much larger, so that they had plenty of accommodation for passengers.

Various marks of the "Tudor" were built, differing in arrangements for, and number of, passengers. Passenger accommodation was for twenty-four in the "Tudor I," to sixty in the "Tudor II" with a longer fuselage. All had "Merlin" engines of one mark or another, according to whether they were intended for high speed, or long range, or load-carryings. Some were unlucky. Two of them disappeared without trace, *spurlos versenkt* on the route between the Azore Islands and the U.S.A. No evidence was found to suggest why they disappeared, and none of those in use showed any sign of failure. To prove the reliability of the "Tudors," Air Vice-Marshal Bennett, who had been flying them on British South American Airways' routes, took over two of them and flew them regularly in the Berlin Airlift—carrying oil and petrol as if they had been tankers—and he never had any trouble with them.

Roy Dobson was created a Knight in 1945. The chief designer, since Roy Chadwick's death, is Stuart Duncan Davies (who escaped being killed in the same accident). Much interesting development work is going on, which cannot be disclosed. But a "Tudor" with four turbo-jet engines has flown at remarkable speed.

The "Tudor IV," as used by British South American Airways under Air Vice-Marshal D.C.T. Bennett.

1948: the "Tudor VIII" airliner with four turbo-jets arranged in pairs under each wing.

Transport Battles with the Sahara

The railway is silted up

The Sahara ? Schoolteachers, cinemas, and stories of the Foreign Legion have done a terrific job of informing everybody of what the Sahara is...everybody except the merchants, miners, colonial officials and soldiers—briefly all those who live in the Sahara or travel across it as part of their daily work.

The Sahara—a French transport problem ? What's the use of mileage statistics ? The most imposing numbers fail to disclose why it is that the French have been conducting a bewildering battle to bring means of transportation into that area which, broadly speaking, extends from the Atlas Mountains to Lake Chad and from the Senegal River to Tunis.

The dimensional aspects become somewhat more apparent if we transfer the Sahara's north-south axis on to a map of North America, and see that it reaches from Montreal to Miami. The west-east axis of the French Sahara, if transferred to a map of Europe, would reach from the Atlantic coast to the Volga.

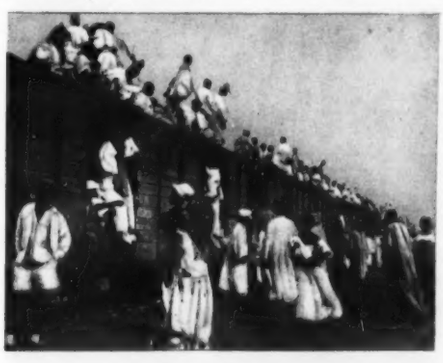
But when we hear that the projected north-to-south railway in this area only runs over a route corresponding in distance to Boston—Washington, that roads as we understand them—except on the fringes of the desert—are non-existent, and that the tracks in the least accessible regions are marked by sand-filled bottles planted up-side-down every hundred yards or so, then we can readily understand that travelling in the Sahara is not one of life's amenities. Yet, we still do not grasp why the primitive camel tracks have not long since been replaced by highways, why the projected Trans-Sahara Railway has never progressed further than Kénadsa, near Colomb Béchar, at the southern foot of the Atlas Mountains, why...

Enough has been written on the Trans-Sahara Railway projects to fill a modest-sized library. Its construction was more or less definitely decided on thirty-five years ago. Financial experts from France, England and Belgium arranged for a foundation conference to convene in August of 1918. And in August of 1918...

The second push forward, which was the fruit of Marshal Lyautey's initiative, failed because of the big economic crisis in 1923. Nor did any permanent results follow the third, and so far last, plan drawn up by the Vichy Government in its organisational law of March 22nd, 1941. It was intended to extend the Algiers—Bou Arfa route through Colomb Béchar, Kénadsa, Beni Abbès and Adrar to In Tassit, with branch routes following the Niger as far as Niamey and Ségu.

Meanwhile, historical and political interludes may not be ascribed the entire responsibility for the "silting-up" of the railway projects. The real sand of the Sahara confronted the would-be constructors with no less imposing problems. The dearth of water precludes the utilisation of steam locomotives, and bringing the electric current along distances of one to three thousand miles from the power stations in the Atlas Mountains would not only be technically difficult, but also completely uneconomical. Diesel locomotives, which require no great quantity of water and could use the native sources of vegetable oil to generate their own electricity, are the only surface vehicles worth considering for the Sahara.

If you ever feel an urge to travel with a crowd like this, even though it never rains it's advisable to wrap yourself well up in a raincoat.



Maybe that, one day, the Trans-Sahara Railway project will be completed. But the air transport specialist cannot help smiling, a little smugly perhaps, when he remembers that the French Minister of Transport, when he opened the first section of this railway on December 7th, 1941, travelled by air in few hours from Paris to Oujda, took the train to continue by night up to Bou Arfa, and completed the last small portion of the trip, from Bou Arfa to Colomb Béchar, in a Pullman car.

In the Pullman car... for any less comfortable accommodation in African transport vehicles means being jammed between squashed tomatoes, rolled-up carpets, egg shells and hampers containing live poultry, with the natives externally spitting on the floor and seats of the scorching hot compartment. (If the natives find the price for transporting live poultry too high, they don't hesitate to yank the hens out of the hampers and kill them on the spot.)

And the automobile ?

The sun over the Sahara cannot burn hotter than the transport question in French West Africa. It is not by chance that, among the oldest archaeological discoveries in the region, drawings of wheeled carriages dating to 600 B.C. were found.

Mail truck along the banks of the Niger. These passengers won't let themselves be enslaved by any timetable.

What's the use of hurrying, anyhow ?

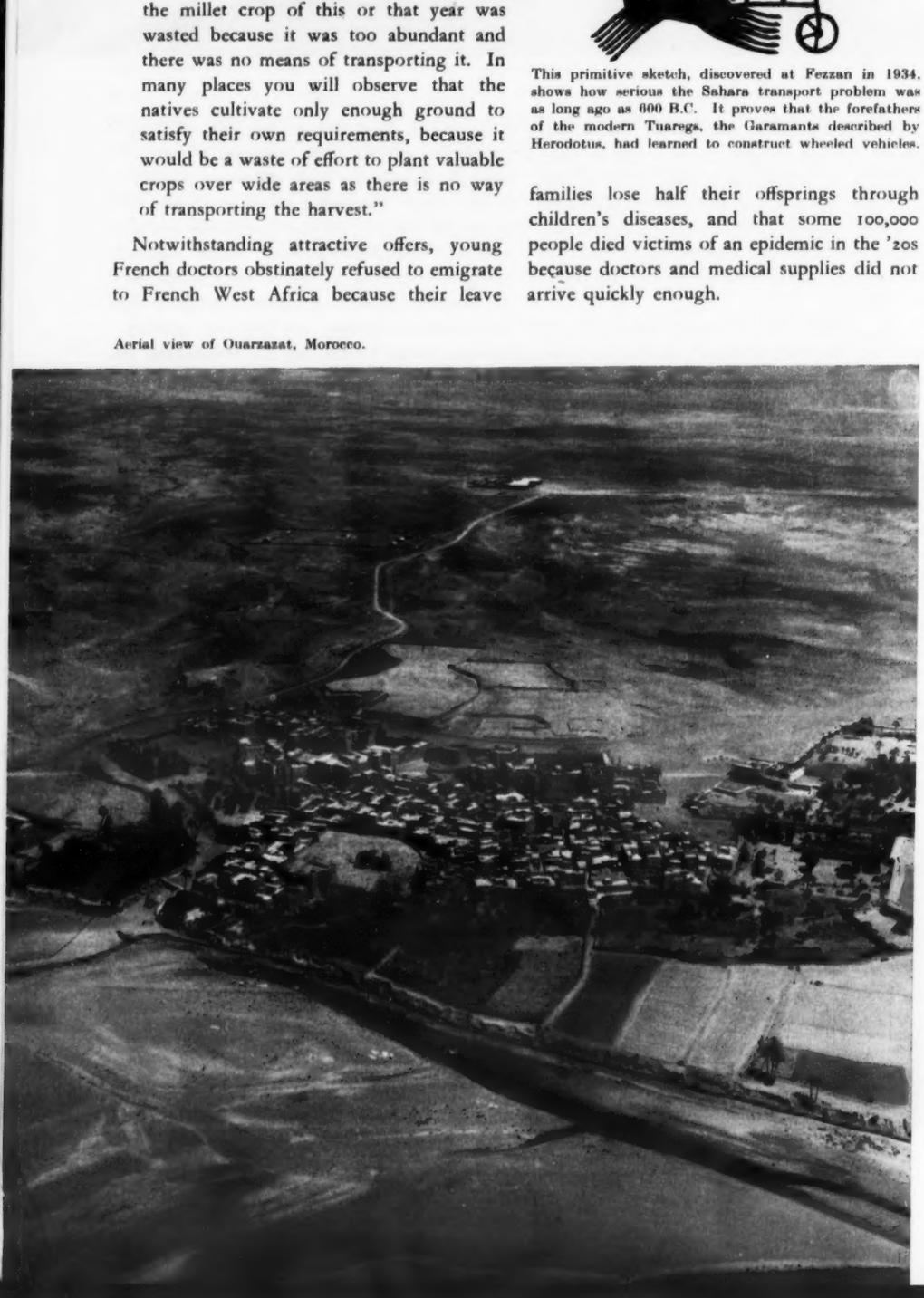
A French colonial expert, writing in 1930, emphasised the lack of suitable transportation and its repercussions on trade, agriculture, mining and health in French West Africa *(Le Problème du Transsaharien—Communication de Edouard de Warren, 1930)*:

> "...The natives at Gao will tell you that the millet crop of this or that year was wasted because it was too abundant and there was no means of transporting it. In many places you will observe that the natives cultivate only enough ground to satisfy their own requirements, because it would be a waste of effort to plant valuable crops over wide areas as there is no way of transporting the harvest."

Notwithstanding attractive offers, young French doctors obstinately refused to emigrate to French West Africa because their leave in Europe would have been spent in a thirty-day trip by boat and train to France, and an equally long and tedious journey back to Africa. De Warren reports that the native families lose half their offsprings through children's diseases, and that some 100,000 people died victims of an epidemic in the '20s because doctors and medical supplies did not arrive quickly enough.

This primitive sketch, discovered at Fezzan in 1934, shows how serious the Sahara transport problem was as long ago as 600 B.C. It proves that the forefathers of the modern Tuaregs, the Garamants described by Herodotus, had learned to construct wheeled vehicles.

Aerial view of Ouarzazat, Morocco.



The cobalt mines hadn't sufficient technicians and engineers, the Niger plantations lacked white inspectors and accountants, all because Dakar was the only gateway into and out of an area which is considerably larger than the entire continent of Europe.

What about automobiles ?

The best way to answer this question is to leave our theorising aside for a while, and to step into one of the mail trucks, which do not run over the sand and stone of the desert, but along primitive tracks following the Niger. Swarms of black men, women and children, and clucking poultry, inside the coach, on the roof and running boards. A goat takes a "seat" inside the compartment. The negro chauffeur emphasises the importance of his office by wearing white-framed sun glasses. His dashboard looks very impressive, but none of the instruments works. He has formed a cushion for himself from a pair of shorts and a few blouses which he has promised to bring for some of the village beauties in the settlements along the itinerary. Though there isn't a soul along the track, he blows the horn very energetically, and if, for some reason or other, one of the passengers wants the journey interrupted, he stops the truck and waits patiently. He does this every fifteen or twenty minutes, besides which he has to call a long halt every half hour in order to let the motor cool off. In view of the temperature, it is inadvisable to touch any of the metal parts of the truck. Once they have reached their destination, the occupants—Europeans and Africans—are of the colour of dust and sand.

Natives love such trips into the unknown by mail truck more than anything else, and take them *en famille* as soon as they have scraped together enough francs. The Touaregs have even invented a word for the automobile in Berber language, and call it *Tomobil*—plural, *Timmaboula*.

Europeans, as they wearily clamber out of the truck, are at a loss to understand the natives' enthusiasm for this mode of travel.

Diverting as it may sound, it seems more than doubtful whether such guaranteed non-scheduled transportation is of any real use, for it is plainly not suited to the serious carriage of persons and goods. All the same, the mail truck does its job at an average speed of fifteen to twenty miles an hour, whilst caterpillar tractors attain an average of only six, and camel caravans one of about two and a half miles per hour. Still, what's the use of even twenty miles an hour in the face of distances of thousands of miles between the main settlements ?

Admittedly, automobile transportation in the Sahara has emerged from its infancy, when cast-away tyres were strewn alongside the tracks like sun-bleached camel skeletons were in earlier days, so that the mainly travelled region

Winging across the Ahaggar range in the Central Sahara.

Arak gorges in the Ahaggar range.

between Ouargla and In Salah was christened *Djena Michelin*—the "Garden of Michelin"—after the well-known French automobile pioneer.

Meanwhile, it is safe, still today, to maintain that automobiles can cope with only certain areas and short distances of the Sahara. The Great Desert is not an ocean of sand. The greater part of it consists of pebbly surfaces and bare rock, where sharp flints challenge even the most modern six-wheeled desert trucks.

The aircraft tackles it

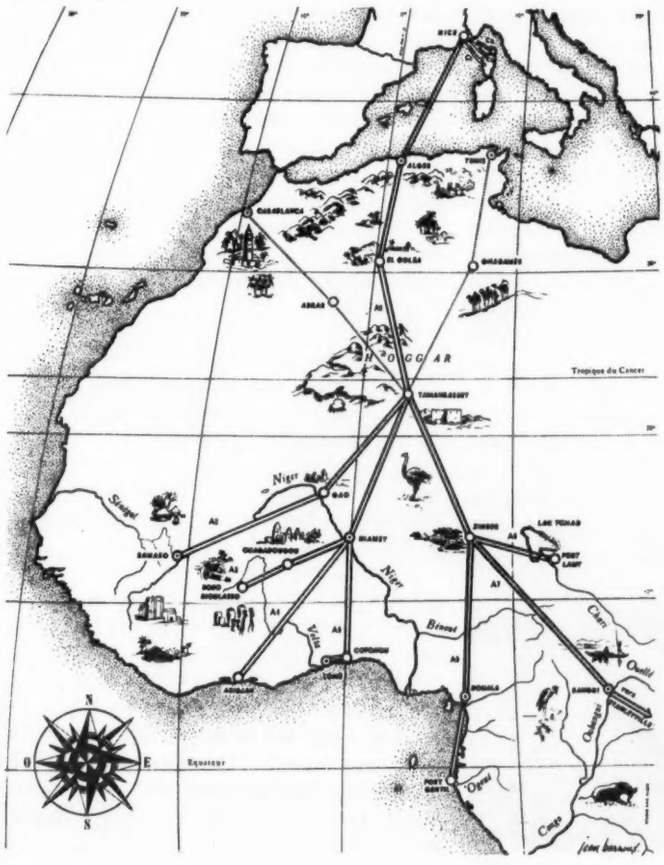
Aircraft tackled Sahara transportation at roughly the same time as the automobile. The beginning was marked by tragedy, for the first Sahara flight cost a prominent French officer, General Laperrine, his life. The first aircraft were single-engined types which, having no radio equipment and no traffic control system to go by, had to fly contact, the pilots anxiously following the camel and, eventually, automobile tracks. If an automobile disappears in the desert, it is relatively easy to find it, as the sand conserves the tracks fairly well. But searching for an aircraft which has no radio is quite another proposition. It was in this way that General Laperrine disappeared, and also an entire French Air Force squadron, in the vast Erg wilderness south of Tunisia.

Today ? The airliner which leaves Nice in the morning arrives two hours later at Maison Blanche, the airport serving Algiers. At two o'clock in the afternoon it reaches El Golea, and after a day of comfortable travelling, the passengers sit down to dinner at Tamanrasset, situated among the Ahaggar Mountains right in the centre of the Sahara. Veiled Touareg warriors stand, lance in hand, at a respectable distance around the runway. The jagged peaks of Atakor N'Ahaggar stand out against the deep purple sky which soon turns to black. A staccato roar announces the arrival of a fully-loaded mail truck, which has taken an entire week to cover the 1,300 miles separating Tamanrasset from Algiers. It is not hard to imagine that the passengers climbing out of their scorching hot cage do not appear as fresh at the dinner table as do the aircraft passengers.

For the big intercontinental airline operators, flying across the Sahara is just like flying over the Atlantic. Air France's DC-4s cross it regularly on the non-stop section between Algiers and Gao, and those of Sabena have to traverse it on their way from Tunis to Bangui, in the Belgian Congo. Large airports equipped with modern radio aids assure safe take-offs and landings.

The real problem of flying from oasis to

Network operated by Aéro-Africaine, one of the regional airline companies flying Sahara services.



Approaching Tamanrasset, in the Ahaggar Mountains. The aerodrome, visible at the top right, seems to lose itself in the sand.

A Lockheed "Lodestar" of Aéro-Africaine landing at Fort Sabbah in Fezzan, Libya.

Night view of the desert hotel at Ouargla, which belongs to the French company, SATT (Société Africaine des Transports Tropicaux).

oasis has been tackled by two French regional airline companies, who are responsible for domestic air transportation in French West Africa : Compagnie Générale Transsaharienne, with headquarters in Paris, and Aéro-Africaine, a subsidiary of Société Africaine des Transports Tropicaux (SATT), which is based at Algiers and maintains a European connection with Nice.

The principal difficulties confronting air operations over the Sahara are the bad visibility and the lack of suitable terrain. The main problem is not the actual flying but the organisation of ground services. Nine months of the year are characterised by sandstorms which envelop the atmosphere in thick dust up to an altitude of 12,000 feet. Often there is no contrasting element in the underlying terrain, so that the landing strips barely stand out against the surrounding ground. Remote strips of sand or flat portions wedged between mighty blocks of volcanic rock frequently serve as runways. Take-offs and landings in the central mountainous area are often effected on astonishingly high aerodromes. Tamanrasset lies at about 5,000 feet above sea level.

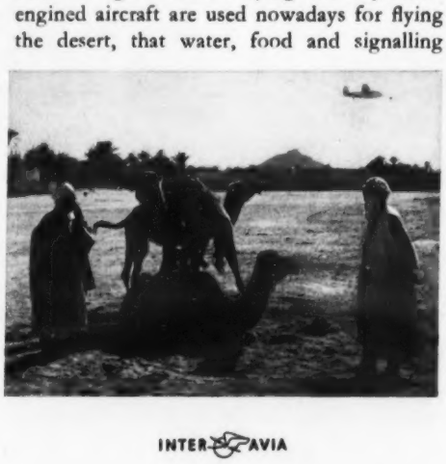
The founder of Aéro-Africaine was the right man to parry the spiteful tricks of the Sahara. Georges Estienne (son of the French tank specialist, General Estienne) is one of the best known Sahara pioneers. Together with his younger brother, who was assassinated in Morocco, he faced incredible hardships and hazards to organise the famous automobile trail connecting Reggan, in the Tuat, with the Niger, and running through the notorious "Land of Thirst"—Tanesruft, a desert within the desert. The Estienne brothers' philanthropical labours did not earn them any great material wealth, but their reputation as automobile transport pioneers has gone beyond many frontiers. In 1933 Georges Estienne founded Société Africaine des Transports Tropicaux, whose comfortable Pullman cars are quite at home on the 3,000 miles of desert rail between Algiers and Fort Lamy. The early experience gathered in the construction of hotels and garages in the desert, today comes in useful for Aéro-Africaine, the airline subsidiary founded in 1936, which now operates a network radiating from Tamanrasset to Lake Chad, the Niger, and the Gold Coast.

A detailed description of how the company grew up would not reveal anything essentially new. A single-engined Farman, which was later replaced by twin-engined Siebel types and ultimately by Douglas DC-3s—such is the story of most airline companies, big and small, wherever they may fly.

The choice of suitable flying equipment is nevertheless interesting. World War I had transformed the automobile from a carefully-guarded luxury into a beast of burden. The transport units of the British Army in Egypt started running across the sand in large-wheeled, robust but light trucks and thereby introduced the first reliable motorised means of desert transportation. During World War II the Americans, with their 10,000 C-47s on all fronts, and in Africa too, showed what could be done with aircraft if one made no bones about making them work hard.

Today the DC-3s acquired by Aéro-Africaine from war-surplus stocks have been replaced by a fleet of Lockheed "Lodestars" which, though they accommodate only fourteen passengers, reveal a more suitable take-off and landing performance as far as desert operations are concerned. After a relatively short take-off run, the dust and sand of the lower air levels is quickly left behind. Low gross weight and rugged construction enable landings to be made on the roughest terrain. And the strong desert winds are no great setback to these machines' cruising speed of 200 miles an hour.

There is no longer any element of risk attached to commercial air operations over the Sahara. It goes without saying that only multi-engined aircraft are used nowadays for flying the desert, that water, food and signalling rockets have to be carried on board, and that the desert trails are still used for navigation, although this aid is now more or less superfluous. A perfectly reliable air traffic control system and the respectable range of the aircraft now in use, always offers a means of returning to base or continuing to the next aerodrome. The fact that Aéro-Africaine has so far flown about one and a quarter million aircraft-miles speaks for itself.



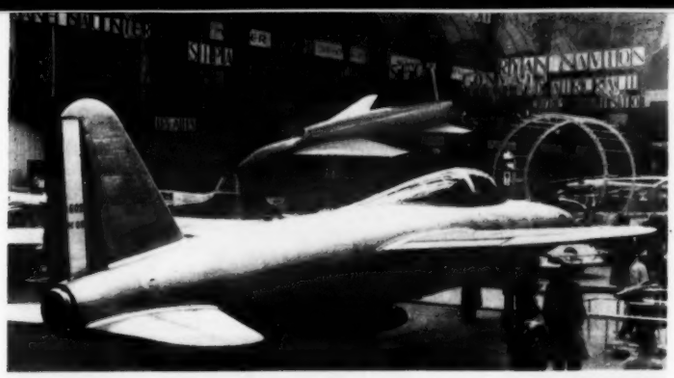
The rôle of SATT, the owners of Aéro-Africaine, is by no means limited to that of a hotel-keeper, offering tourists Moorish palaces with shady halls, heavy Berber rugs, copper ornaments and every conceivable amenity. The company's automobiles and aircraft have become benefactors of humanity and colonisers of the wilderness.

Only twenty years ago Tamanrasset consisted of a few native huts surrounding an oasis. Today's visitor finds a large hotel, an inn, a weather station, a research laboratory and many small houses of red clay, which have given a new face to the old desert fort where the "Father of the Desert," Père Foucauld, was assassinated in 1916. Connections between the southern districts of French West Africa and the mother country are no longer dependent on the seasonal risings of the rivers, formerly the condition on which people could reach Dakar whence the boat took them in ten days to Marseilles.

More and more radio aids and weather stations are being established each month. True, the natives are sometimes recruited at high speed to light old newspapers along the edges of the runway for bringing in aircraft after night has closed in. But it will not be long before instrument landing installations make blind approaches an everyday occurrence even in the thickest sandstorm.

Granted, automobiles will remain indispensable for short hauls in the Sahara. And it is also true that camel caravans still trek from oasis to oasis. The large caravans transporting salt from Agadès, in the Air region, to Bilma and Fachi comprised over 5,000 camels in the year 1935, and were escorted by units of some 130 riflemen. Tomorrow ? The day will come when the last camel will be unloaded and its cargo stowed in the hold of a freight aircraft.

Paris Sidelights



SO 6020 "Espadon" ; in the rear can be seen the SE 2410 strike aircraft characterised by its air intake on top of the fuselage.

The eighteenth Paris International Aircraft Show, the first International Congress of Aeronautical Manufacturers, and lastly the General Conference of the Fédération Aéronautique Internationale once again made the City on the Seine the focal point of interest for all those who are in any way connected with aeronautics. People in the branch converged on Paris from all points of the globe, in order to obtain an idea of the present level attained in aeronautical development, to form new business connections and to cement old relations. The joyfully pulsing life of the French metropolis in no way disturbed the settling of such business questions ; in fact, one is rather inclined to attribute to its charm much of the success of this year's Salon. As in the case of earlier shows, this year's manifestation was chiefly characterised by the participation of the French manufacturers. A series of proven and partly production-type aircraft—from high speed experimental designs to single-seat ultra-light aircraft—bore witness to the fact that the efforts of the French aircraft industry are beginning to show satisfactory results.

Of the other exhibitors, the Society of British Aircraft Constructors and the U.S. aircraft and aero-engine firms were hardly represented in a manner befitting their international importance, with the result that the Continental note was still more predominant. The Italian firms grouped in the Associazione Imprese Aeronautiche made an excellent impression. They seem to have left their postwar difficulties well behind, and their high-class aircraft and engines deserve every success. The international scope of the Paris Show was further emphasised by the participation of the Czechoslovak national firms, the Dutch Fokker concern, and finally the Swiss Pilatus Aircraft Works. Also, it was a pleasant surprise to see that the Turkish aircraft industry had provided a stand.

A stroll through the Salon

France

Understandably, the stands provided by the French national aircraft concerns formed the nucleus of the show. *SNCA du Sud-Est* exhibited models of the SE 1010 four-engined long-range aerial survey aircraft, a model of the SE 1030 airliner of the same family, a model of the SE 1210 experimental flying boat and of the SE 4000 four-seat amphibian powered by a Mathis G.16 dual engine of 445 H.P. As regards actual aircraft, the SE 3110 two-seat helicopter was the only Sud-Est type on show in the Grand Palais. Further exhibits included a model of the SE 2010 "Armagnac" four-engined airliner, which recently flew from Toulouse to Bordeaux at an average speed of over 310 m.p.h., and a wind-tunnel model of the SE 2410 fighter powered with two Rolls-Royce/Hispano "Nene" turbo-jets positioned one above the other.

Certainly the most interesting exhibit shown by *SNCA Sud-Ouest* was the SO M2 research aircraft, which is in reality a sort of flying model of the SO 4000 twin-jet bomber now under construction. Equipped with a Rolls-Royce "Derwent 5" jet engine, the SO M2 has been undergoing flight tests since April of this year. Another exhibit which attracted visitors' attention was the SO 6020 "Espadon" jet fighter. The very promising SO 30 P twin-engined airliner, which has now changed its name from "Bellatrix" to "Bretagne," following a rather long development period, is likely to be in service with Air France before the end of this year. Whilst this aircraft was shown only in model form, the SO 95 "Corse II" twin-engined feeder transport and the SO 7060 W "Deauville" all-metal three-seat personal aircraft were on full show.—With the SE 2010, the SO 30 P and the smaller SO 95, France possesses three useful commercial transport aircraft of suitably graded size.

SNCA du Centre exhibited their four main personal aircraft : the basic NC 853 two-seater, and the NC 851 two-seater, NC 859 two-seater and NC 856 four-seater developed from it. A model was shown of the NC 860 twin-engined four-seat touring aircraft, which has been undergoing flight tests since last March. An idea of this firm's extensive programme was given by the models shown of the NC 211 "Cormoran" large cargo transport, the NC 1080 single-jet carrier-borne fighter and the NC 1072 night-fighter (derived from the NC 1071 twin-jet trainer). Special attention was earned by the model exhibited of the twin-jet NC 270 bomber and of a projected three-engined freighter, the NC 300, which is somewhat reminiscent of the American Northrop "Pioneer." The models of the NC 2451 helicopter with jet units mounted at the tips of its two-blade rotor, and of the five-seat NC 2003 helicopter derived from the NC 2001 experimental type, showed that SNCAC's rotary-wing department is ambitiously pursuing its development programme.

The most impressive product exhibited by *SNCA du Nord* was the Nord 2101 "Norazur" twin-engined pusher-type feeder transport. An all-metal high-wing monoplane with accommodation for eight to ten passengers, its power plant consists of two Potez 8 D 03 engines furnishing 420 H.P. take-off power. Other SNCAN exhibits included the well-known Nord 1203 "Norécrin" four-seat personal aircraft, and models of the Nord 1601 twin-jet experimental aircraft, of the Nord 2200 single-engined single-seat carrier-borne fighter, and of the Nord 2500 twin-engined cargo transport.

The first object to catch the visitor's eye on the stand of *S.A. des Ateliers d'Aviation Louis Bréguet* was one of the outer wings of the Bréguet 761 "Deux Ponts" (two-decker) four-engined cargo and passenger transport. This provided an impressive idea of the dimensions of this aircraft, whereas two sectioned models showed its external features and its interior layout. Cut-away models of the twin-engined Bréguet 890 H and of its four-engined 892 S "Mercure" version were also on show. A model of the Bréguet 960 naval attack aircraft, fitted with an Armstrong-Siddeley "Mamba" propeller-turbine in the nose and a Hispano "Nene" turbo-jet with its exhaust outlet forming the rear fuselage, disclosed that this aircraft can carry torpedoes or bombs, as well as rocket missiles. It is designed for a two-man crew and is expected to reach a maximum speed of about 560 m.p.h.

Besides the electrically-adjustable MD 304 three-blade and MD 404 four-blade propellers, and the hydraulically-adjustable MD 412 four-

SE 3110, showing engine installation.

[1] Cf. "French Aircraft Manufacturing in 1949" in INTERAVIA, Review of World Aviation, Volume IV, No. 5, pp. 266-273.

Fouga CM.8 R-13 "Cyclone."

Piaggio P.136.

blade propeller, the only big exhibit provided by *Avions Marcel Dassault* was the Dassault MD 450 "Ouragan" jet fighter.

Ets. Fouga & Cie. aroused a certain amount of interest with the CM 8 R-13 "Cyclone" lightplane, which is a modified CM. 8 high-performance sailplane powered by a tiny Turbomeca TR 011 turbo-jet furnishing 200 lbs. thrust, and will be used primarily for meteorological research at high altitudes.

Morane-Saulnier exhibited the MS 474 two-seat trainer and the MS 701 twin-engined liaison aircraft. The MS 474, presumably built for carrier-borne operations, is a low wing monoplane with a retractable tail-wheel undercarriage. It attains 290 m.p.h. maximum speed on its engine of 670 H.P., but a higher figure may be expected from the MS 475 version powered with a 840-H.P. Hispano-Suiza 12 Y 45. The all-metal MS 701 is normally a four-seater, but it can also be fitted out as a flying ambulance, offering accommodation for one or two stretcher patients and an attendant, in addition to the pilot. It is powered with two 180-H.P. Mathis 8 G 20 engines. Morane-Saulnier also exhibited propellers; the two-blade wooden adjustable MS 49-101 E for three pitch positions (fine, course and feathered) and the MS 49-101 M which can be adjusted through 15 degrees.

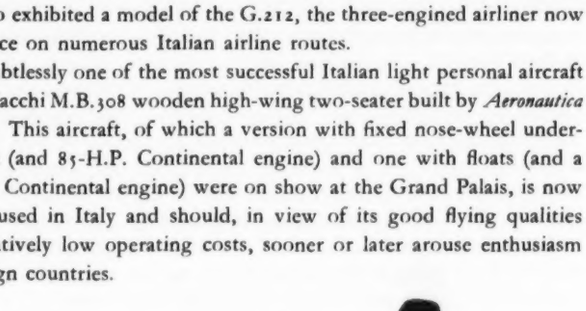
Société Française de Construction Aéronautique (SFCA) exhibited the Lignel 46 "Coach" four-seat low-wing personal aircraft, which earned itself a good reputation on the occasion of last year's round-Italy flight contest, when it carried home three first prizes. Further exhibits in the light aircraft field comprised the well-known four- to five-seat SUC-10 "Courlis" high-wing tourer built by *Société d'Etudes et de Constructions Aéro-Navales (SECAN)*,[2] the SIPA S 90 and S 901 two-seat low-wing types and the Starck AS 57 two-seater powered with a 105-H.P. Walter engine, built by *Société des Avions Starck*. There was furthermore a single-seat lightplane on show, which is officially known as the "New Look," though its 20-H.P. engine has earned it the popular nickname of "La motocyclette de l'air." The SCAN 30 twin-engined amphibian built by *Société de Constructions Aéro-Navales* was not shown inside the Grand Palais, but at an improvised wharf almost beneath the Pont Alexandre III. The SCAN 30 is a licence-built Grumman "Widgeon," and is now being produced in France.

[2] Cf. "Electric Spot-Welding of Pressed Sheet Parts in the Serial Manufacture of the SECAN 'Courlis' Personal Aircraft" in INTERAVIA, Review of World Aviation, Volume IV, No. 2, pp. 93-96.

Italy

The *Fiat S.A.* stand featured the Fiat G.46 all-metal two-seater[3] and the Fiat G.59B fighter-trainer derived from the G.55 fighter. The G.46, which can be powered with a 190-H.P. Alfa Romeo 115-1Bis, a 245-H.P. de Havilland "Gipsy Queen 30" or a 220-H.P. Alfa Romeo 115-1Ter, attains, with the "Gipsy Queen 30," a maximum speed of 152 m.p.h. and a range of 530 miles, the gross weight being 3,150 lbs. The Fiat G.59 (G.59A as a single-seater and G.59B as a two-seater) is equipped with a 1,600-H.P. Rolls-Royce "Merlin 500" and possesses, at a gross weight of 6,700 lbs., a cruising speed of 292 m.p.h., a range of 530 miles and a service ceiling of 37,400 ft. In addition to the actual aircraft, two detailed models of the G.46 and G.59D were on show. Fiat also exhibited a model of the G.212, the three-engined airliner now in service on numerous Italian airline routes.

Doubtlessly one of the most successful Italian light personal aircraft is the Macchi M.B.308 wooden high-wing two-seater built by *Aeronautica Macchi*. This aircraft, of which a version with fixed nose-wheel undercarriage (and 85-H.P. Continental engine) and one with floats (and a 90-H.P. Continental engine) were on show at the Grand Palais, is now widely used in Italy and should, in view of its good flying qualities and relatively low operating costs, sooner or later arouse enthusiasm in foreign countries.



SCAN 30.

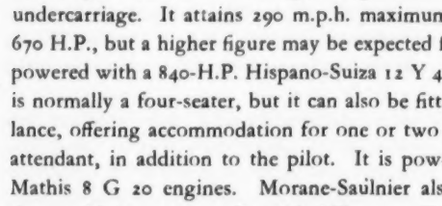
Success was also scored by *Piaggio*. The P.136 twin-engined amphibian of this firm was one of the main attractions on the Italian stands and also of the entire show. Equipped with two 215-H.P. Franklin engines and adjustable-pitch pusher propellers, this all-metal aircraft provides accommodation for five and attains a maximum speed of 180 m.p.h. at a gross weight of 5,410 lbs. Piaggio furthermore exhibited a model of the P.140, a cargo and passenger transport aircraft derived from the P.108 four-engined transport and bomber type.

Breda-Zappata showed a model of its BZ.308 four-engined long-range airliner,[4] now being flight-tested, which has a gross weight of between 101,400 and 105,800 lbs.

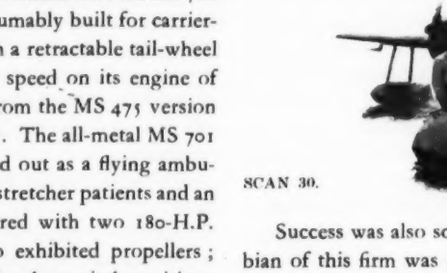
The SAI S.1001 "Grifo" of *SAI Ambrosoni & Cie.* is in many respects reminiscent of the SAI racing types built before the war. This single-engined four-seat wooden low-wing monoplane with fixed tail-wheel undercarriage recently attracted some attention when two pilots crossed the South Atlantic in one of them. The "Grifo" was accompanied on the exhibition stand by a model of the SAI S.7 two-seat trainer, which was built in large numbers already before the war and is now in quantity production again, though with various improvements.

[3] Cf. INTERAVIA, Review of World Aviation, Volume IV, No. 3, pp. 164-165.
[4] Cf. INTERAVIA, Review of World Aviation, Volume III, No. 12, pp. 670-673.

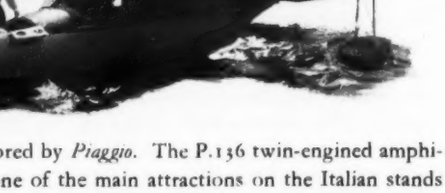
Bréguet 960.



Piaggio P.140.



Fokker S.14.



Holland and Czechoslovakia

The Dutch *Fokker* concern seems to be concentrating at present on the development and manufacture of training aircraft, and consequently exhibited four such types, some in model form. The two- to three-seat low-wing Fokker S.11 "Instructor" with fixed tail-wheel undercarriage, and its S.12 version with fixed nose-wheel undercarriage, are at present being flight-tested ; the S.11 is likely to be built in large numbers. Identical except for the undercarriage, both types are powered with 190-H.P. Lycoming O-435-A engines. The S.13 is a twin-engined trainer accommodating five to six occupants. It was shown in model form along with the Fokker S.14 two- to three-seat jet trainer. The S.13 is powered with two Pratt & Whitney 600-H.P. "Wasp" engines, is an all-metal low-wing monoplane, and is intended for the training of pilots, navigators, observers and bomb-aimers. The S.14, which has a Rolls-Royce "Derwent 5" turbo-jet, is primarily for acquainting fighter pilots with jet aircraft.

The nationalised *Czechoslovak Aircraft Works* exhibited their two new personal aircraft, the M-2 "Skaut" and the M-3 "Bonzo." Both these aircraft are derived from the well known M-1 C "Sokol." The M-2 is a two-seater of wooden construction, equipped with a 75-H.P. Praga D engine, and the M-3, also of wood, is a four-seater with retractable undercarriage and 160-H.P. Walter "Minor 6-III" power plant. Other Czech exhibits included the Zlin 22 two-seater powered with a Praga D, and the well known Aero 45 twin-engined four-seat personal aircraft, one of the few twin-engined all-metal personal aircraft available today. A more powerful version of the Aero 45, having 160-H.P. Walter "Minor 6-III" instead of 105-H.P. "Minor 4-III" engines, bears the designation Aero 145. This has a slightly modified fuselage nose and can, thanks to the greater power available, carry five instead of four occupants.

Switzerland and Turkey

The Swiss *Pilatus-Flugzeugwerke A.G.* exhibited its P-2 two-seat trainer and the P-4 five-seat personal aircraft and all-purpose light transport.

The stand of *Türk Hava Kurumu*, the Turkish aircraft concern, was limited to models of the T.H.K.2 aerobatic single-seater, the T.H.K. 5 A twin-engined low-wing monoplane, the three-seater T.H.K. 11 personal aircraft, and the T.H.K 13 experimental all-wing aircraft.

Great Britain and U.S.A.

As regards actual aircraft, the British and Americans together exhibited only three types : the British Bristol 171 helicopter and the U.S four-seat Beech 35 "Bonanza" (185-H.P.) and Ryan "Navion" (205-H.P.) personal aircraft.

The Bristol Aeroplane Co., Ltd., exhibited models of a number of its latest products. A sectioned model of the four-engined Bristol 175 airliner gave a good idea of the impressive interior layout projected for this type. The prototype Bristol 175 will be powered with four Bristol "Centaurus" reciprocating engines, whereas it is intended to equip later versions with four "Proteus" propeller-turbines. An imposing model of the extra-large Bristol "Brabazon 2," likewise to receive Bristol "Proteus" propeller-turbines, brought back to memory that the keenly anticipated first flight of the prototype "Brabazon 1," temporarily to be equipped with eight piston engines, should take place shortly.

Vickers-Armstrongs Ltd. attracted visitors' attention with a whole series of models, the most interesting of which was probably that of the Vickers-Supermarine 510 experimental jet aircraft. At present undergoing flight tests, this type is intended for practical research on the problems of high-speed flight at high subsonic and supersonic speeds. The collection was continued with models of the "Viscount 700" commercial transport powered with four Rolls-Royce "Dart" propeller-turbines, the Vickers "Viking" airliner experimentally fitted with two "Nene" turbo-jets, as well as the "Valetta" transport and Vickers T.1 "Varsity" training aircraft, both derived from the "Viking."

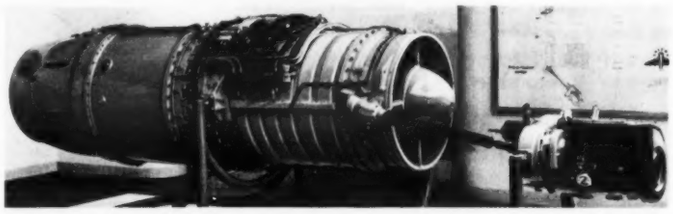
The stand of *Lockheed Aircraft Corp.* consisted of a representative showing of models of the "Constellation" and "Constitution," of the P2V "Neptune" and finally of the familiar F-80 "Shooting Star" jet fighter.

Consolidated Vultee Aircraft Corp. exhibited a large collection of "Convair-Liners" bearing the emblems of the many airline companies now using this type.

Douglas Aircraft Co., who showed models of the well-proven DC-3 and of its higher-powered version accommodating 32 to 40 passengers, the "Super DC-3," gave rise to comparisons and the question of whether the many DC-3s honourably retired from service will not make a triumphant return as "Super DC-3s." Douglas also exhibited a model of the four-engined DC-6, of which the prototype of a freighter version, the DC-6A, should be completed shortly.

Reciprocating and turbine engines

As at the 1946 Salon, this year, too, the reciprocating engines of small and medium output were strongly in evidence. However, there was little new to be seen in this domain, for the majority of exhibits were well-known types or else new versions which differed from the old ones merely by the nature of their auxiliaries.



ATAR 101 B.

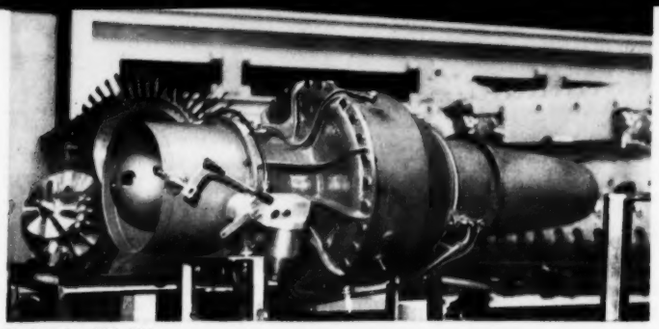
Reciprocating engines of small and medium output

In addition to two four-cylinder in-line engines, the 160-H.P. 4 D 01 and the 220-H.P. 4 D 31, *Potez* exhibited a supercharged eight-cylinder in-line, the 8 D 30, which has a dry weight of 740 lbs. and furnishes 445 H.P. The 12 D 30 flat-twelve of 640 H.P., equipped with a single-stage supercharger, appears to have been derived from the well known 12 D 03 type. *Salmson* showed five-, seven- and nine-cylinder radials of 90 to 260 H.P., and *Mathis* (Mecamat) presented its well-known G-series engines. Aircraft engines of under 100 H.P. were exhibited by *Moteurs Lutétia* (Marcel Echard), whose 6 A 01 six-cylinder two-stroke engine with six dual cylinders arranged in stellar pattern gives 70 H.P., and by *Victor Minié Aéronautique*.

The Italian aero-engine industry was represented by three manufacturers. *Alfa Romeo* exhibited the proven 220-H.P. Alfa 115 Ter six-cylinder in-line, whilst *Isotta Fraschini* showed the no-longer-new "Asso" 6-R.C. 1Z six cylinder in-line of 335 H.P., the 1,035-H.P. "Delta" R.C. 20/55 twelve-cylinder inverted V-type, and lastly the "Zeta" R.C. 25/60 24-cylinder X-type of 1,575 H.P. A really small engine, intended for powering lightplanes and sailplanes, was exhibited by *SAI Ambrosini*—the P.25 two-stroke flat-two which has a dry weight of only 38 lbs. and an output of 22 H.P.

The only engines of U.S. manufacture on show at the Grand Palais were a 65-H.P. *Continental* A-65 and a 185-H.P. Continental E-185 fitted with a Koppers "Aeromatic" two-blade adjustable-pitch propeller.

Czechoslovakia showed quite a number of types, comprising the Praga D flat-four of 75 H.P. and the series of four- and six-cylinder

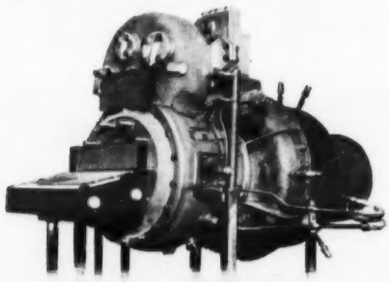


Turboméca TR 011.

Walter engines, namely, the 65-H.P. "Mikron III," the 105-H.P. "Minor 4-III" and the 160-H.P. "Minor 6-III."

Large reciprocating and turbine engines

The 2,220-H.P. Arsenal 12 H and 3,940-H.P. Arsenal 24-H in-lines, both manufactured by *Arsenal de l'Aéronautique* and achieving their maximum output with water injection, are well known. The 2,000-H.P. series of *SNECMA* 14-cylinder twin-row radials, the 14 R, 14 N and 14 U, were mentioned in last May's issue of this magazine, so that the only large French piston engine we shall mention is the HS 12 B twelve-cylinder V-type in-line of 2,170 H.P., manufactured by *Hispano-Suiza*. Derived from the HS 12 Z, this engine differs from preceding versions mainly through the strengthening of various parts and a higher degree of supercharging ; like earlier models, it is also liquid-cooled and has direct fuel injection.



Turboméca TT 782.

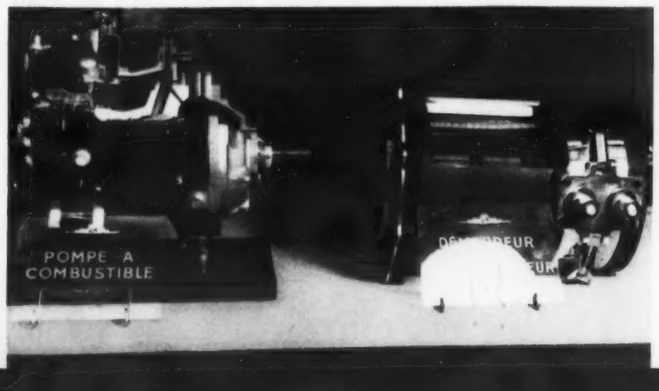
An interesting exhibit was provided by *The Bristol Aeroplane Co., Ltd.* This was a sectioned model of the "Hercules 763" 14-cylinder twin-row radial, a sleeve-valve engine equipped with supercharger, which was developed for the Handley Page "Hermes 4" four-engined airliner and furnishes a take-off power of 2,100 H.P. at sea level.

The *Voisin* branch of SNECMA exhibited the ATAR 101 B axial-flow turbo-jet which furnishes 4,850 lbs. thrust at 8,050 r.p.m. [5] The SNECMA TB.100 propeller-turbine, the TGAR-1008 turbo-jet and the TGA-Ibis propeller-turbine, the latter two products exhibited by *SOCEMA*, were also described in last May's issue. A great deal of attention was attracted by the small turbines exhibited by *S.A. Turboméca*, and chiefly by the TT 782 turbine unit which weighs only 165 lbs. and furnished a maximum output of 110 H.P. at 35,000 r.p.m. during its recent certification tests. The TR 011 turbo-jet, derived from the TT 782, weighs 100 lbs. and gives 198 lbs. static thrust at 37,000 r.p.m.

The British manufacturers' stands were high-lighted by the propeller-turbines. *Armstrong-Siddeley Motors Ltd.* exhibited the "Mamba," "Double Mamba" and the "Python." *The Bristol Aeroplane Co.* showed the "Proteus" propeller-turbine and a model revealing how "Proteus" turbines will be paired for installation in the eight-engined "Brabazon 2" and the ten-engined Saro SR/45 flying boat.

[5] INTERAVIA, Review of World Aviation, Volume IV, No. 6, pp. 345-349.

Air Equipment starter (Rotax licence) and fuel injection pump for turbine engines (Lucas licence).



Accessories

Though there were many interesting products exhibited on numerous stands, the more observant visitor could not help coming to the conclusion that the desired standardisation in the aircraft accessories field is still far away. International co-operation in this respect would above all be useful with regard to commercial transport aircraft, for it frequently occurs that maintenance and overhaul work has to be carried out away from an airline company's home base. In France the grouping of the main manufacturers of accessories in the *Union des Matériels d'Equipments Aéronautiques* should contribute towards standardisation ; appreciable results, however, are as yet not discernible.

The following list of a few of the main French exhibitors and their products will serve to give an idea of the scope and trends of this branch of aeronautics. *Société ABG* showed ignition systems for reciprocating engines, a series of magnetos, and various spark plugs and engine instruments. The stand of *Air Equipment* featured blowers for airliner cabin pressurisation installations, starters and fuel injection pumps for turbine power plants, an electric hoist for the Nord 2500 and Centre NC 211 cargo transports, and finally fuel injection pumps specially designed for the SNECMA 14 R 14-cylinder twin-row radial. *S.A. Bronzavia* exhibited various types of exhaust manifold and fuel injection pump, and also demonstrated models of airport equipment, airborne transmitters and receivers. *Ets. Faure Herman* showed electric tachometers for reciprocating and turbine engines, and fuel measuring equipment, whilst *Ets. Labinal* had as main exhibit the new "Labex" voltage regulator for airborne installation. The *Legastelois* distributing agency, and its subsidiary "Tout pour l'Avion," which also sells SNCA du Nord products (Nord "Norécrin"), provided a stand which illustrated this firm's wide activities. *S.A. Messier* exhibited a nose-wheel and a main landing wheel of the Bréguet 763 freight transport aircraft, as well as a complete undercarriage for the Dassault MD 315. The latter was mounted on the test bench which Messier uses for executing endurance retraction and extension trials. *Ets. Facel-Métallon* showed a selection of cold-rolled strips, and drawn, seamless-welded tubes of stainless steel. Various magnesium castings as well as drawn and rolled magnesium specimens were presented by *Société Générale du Magnésium*. Radio altimeters, glide-path and localiser receivers, radio beacons, R/T equipment, and radar systems for various purposes were exhibited by *Société Française Radio-Electrique*, all these products having been developed in the firm's own laboratories. *Cie. Française Thomson-Houston* also showed radar equipment, including a complete GCA installation. Other exhibitors included *Société Airindex*, which manufactures and showed engine instruments, air heaters for de-icing systems, and oil coolers ; *Société Kléber-Colombes* (pneumatic de-icing systems for wings, control surfaces and propellers), and the *Laboratoire Central de Télécommunications*. The latter's stand showed a radar receiver which eliminates undesirable reflections from stationary obstacles and can be adapted to the majority of existing radar installations ; a twelve-channel transceiver working on metre waves ; modern electron tubes for metre, decimetre and centimetre waves ; and finally a model of a radio-navigational system incorporating omni-range and D/F equipment.

Whilst the foregoing brief list of some of the more important French manufacturers and exhibitors would have to be supplemented by a long list of the various British, Italian and U.S. firms present in Paris, it nevertheless conveys an idea, not only of the scope of this industry, but also of the increasingly important rôle the manufacturers of accessories are playing in the aeronautical industry as a whole.

Esmeralda at the Air Show

Thousands of people travelled to Paris in May. Most of them went for the avowed purpose of seeing what's new in the aviation world—the 18th Paris Air Show was on. Some even conceded that they were going to sound out their competitors in the aviation game on any novelties they may have up their sleeves. And all of them went there—though nobody admitted it—because they wanted to enjoy a few days of Paris in the Spring, tra-la, tra-la.

Esmeralda assumes that the majority of visitors got what they were after, or nearly, or at least believe they did. Our Favourite Air Hostess went around the stands in the Grand Palais, admired the jet fighters and wondered how they stayed in the air on those wing stubs. She visualized touring the countries in a small, private aircraft, and like most other feminine visitors fell for the little twin-engined Piaggio amphibian. The ideal boyfriend of the future, she says, will own not only a convertible, but also an amphibian. "Come on over so I can show you my etch—beg your pardon, my amphibian." Esmeralda also tried to find out what other women thought of the Salon de l'Aéronautique. The fair sex apparently took her for a public opinion pollster, for most of those questioned said they "didn't know," they hadn't got a clue to aviation or just weren't interested but went because Maurice wanted them to go along. The girls at the stands ate chocolate, paid visits to each other, read books and looked *blasée*.

At intervals Esmeralda concentrated on the Spring part of Paris. She walked along the wide boulevards, called on one or two of the *couturiers* and watched the cars roar down the streets again in purposeful abandon. She lingered in the quiet squares and thought the Place Vendome looked a little incongruous with dozens of cars parked in front of its graceful buildings, instead of carriages and counts in powdered wigs. She had coffee at Fouquet's on the Champs Elysees; in the evening she took in the show at the Lido. Escorted by the navigator, she toured the night spots and, looking back on it all, decided that Paris is once more the place where you must go from time to time just to be able to live again for a little while.

Esmeralda went to Orly field on May 14th to watch the static exhibition and air display organised by the Union Syndicale des Industries Aéronautiques as a conclusion to the Salon. She had a special pink ticket reserved for the brass, with detachable corners, two for the motor-coach trip to the airfield and return, one for the luncheon, one for the official enclosure. Through some strange organisational twist of which only the Latin mind is capable, she was finally set down in a village somewhere at the edge of Paris's huge intercontinental airport. No enclosures, no aircraft, no lunches. Instead she found a very small girl with very large loaves of bread and a grubby young man selling sausages and sandwiches. Dozens of smart-looking motorcycle cops were careering up and down the road, impressing the local inhabitants but remaining unimpressed when Esmeralda waved her pink ticket in their faces. Nor did the Latin minds of the ticket inspectors worry—this was the area for the masses of the people, they told her; they didn't know where the official enclosure was... *"Je regrette..."* Two newspaper boys selling "France Soir" finally helped her out: they had received orders to hawk their papers amongst the officially invited guests and offered her a seat on a board in the back of a truck for the four-mile trip over rutted little roads along the airport periphery to the other side of the field. On the way the newspaper boys defiled the official guests in picturesque language: *"Qu'est-ce que c'est les officiels? C'est des mecs qui s'mettent des gants blancs mais qui t'achètent pas d'canard..."*

Esmeralda collapsed into the first seat in the front row of the official enclosure, exhausted from the ride. Two chairs further down sat an elderly man who seemed familiar; somebody with an owlish look in his eyes. Ramadier, she realised, the Minister of Defence, and then the flying started. Esmeralda was surprised.

She discovered that without going to the trouble of announcing "Brabazon Programmes" or "Clipper

The girls paid visits to each other.

Side-glance from the air show.

She also did the night spots.

On the wrong side of the airfield...

...and on the right.

The "Armagnac," pride of the French air industry.

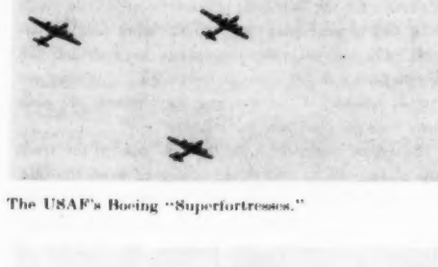
The "Bretagne."

The Dassault MD 315.

The "Espadon."

The "Ouragan."

The USAF's Boeing "Superfortresses."



The RAF's Gloster "Meteors."

The U.S. Navy's "Truculent Turtle."

Programmes"—some of whose star turns have meanwhile given up the ghost or have not yet seen the light of day—the French have quickly completed a range of modern commercial aircraft promising enough to induce the Government to impose a "Buy French" policy on its air transport system.

Very impressive was the fly-past of the "pride of the French aircraft industry," the Sud-Est SE 2010 "Armagnac" eighty-passenger four-engined long-range transport, a sleek, 75-ton aircraft looking much smaller than its true size (efficient aircraft always seem to look graceful). Fifteen "Armagnacs" are to be produced for Air France. The twin-engined Sud-Ouest SO 30P "Bretagne," of which 40 are on order for the Government, is to be introduced on Air France's medium-stage services; the company will conduct full-scale operational tests with the machine, and if the type's operating economy is not "too inferior" to that of the "Convair-Liner"—which Air France had planned to order—about thirty SO 30Ps will be adopted by Air France. The "Bretagne's" single-engine performance made an outstanding impression. On the day before the display, the aircraft took off at Orly, landed at Bordeaux and flew back to Paris, all on one engine.

In the cargo transport category, two heavies lumbered through the sky, the four-engined double-deck Bréguet 761 "Deux-Ponts" and the much-defiled Centre NC 211 "Cormoran." Both took off after unexpectedly short runs—they were not heavily loaded—and what they lack in grace is probably made up for by utility. Speaking of grace, Esmeralda wonders how the designers of passenger airliners manage to instil an element of elegance in their products, in view of the huge loads of stuff they must carry these days. And you'd be surprised at the nature of the stuff! She went along to see P.A.A.'s "Stratocruiser" in Paris at the end of April, just after the opening of the aircraft show, and there she gathered some amazing information from an amazing news-sheet the PAA people handed her. Passengers, the release stated, will get more Scotch whisky aboard than any other kind of alcoholic drink, since the "Stratocruiser" carries 120 4½-ounce bottles of Scotch, compared with only 40 bottles of Rye, 30 of Manhattans, and on down the line. All this booze weighs 67 pounds, against only 24 pounds of reading matter aboard . . . The release went on to compare the noise produced by the propellers with the warbling of birds and proclaimed that the shrill scream of the brakes—"another characteristic sound"—was "done on purpose": the "Stratocruiser's" brakes *must* squeal . . . Our Favourite Air Hostess would like to know if the public relations man in question wrote his piece before or after taking a ride in the "Stratocruiser's" well-stocked bar.

The range of new French transports was rounded off by the Sud-Ouest SO 95 "Corse" twin-engined 10/13-passenger feeder liner and the Nord 2100 "Norazur" twin-engined pusher type, which in its commercial version carries a two-man crew and seven passengers. In a class by itself is the Dassault M.D. 315, powered with two engines of 600 H.P., which is being built for the French Air Force in considerable quantity for duty as a light military transport (*"avion de liaisons coloniales"*) but certainly would also make an excellent short-range passenger transport.

All these aircraft, with very few exceptions, showed off their performance with one or two engines (out of two or four, respectively, of course!) inoperative, and this practice seems to have become a standard feature of multi-engined aircraft demonstrations. Several types also displayed the kind of landing-run reduction that can be accomplished by the use of reversible-pitch propellers.

The weather had gradually closed down during this time. Visibility was two miles, and Esmeralda was afraid the jets were out for this session. She was wrong. Soon, the Centre NC 1071 twin-engined carrier-borne attack aircraft, looking like three sausages placed parallel to each other, came roaring by, followed by the Sud-Ouest S.O. 6000 "Triton" two-seater trainer, the huge Sud-Ouest S.O. 6020 "Espadon" and the Dassault 450 "Ouragan" swept-wing fighters. The little "Triton," one of France's earliest jets, shot around the airport periphery at unbelievable speed. All aircraft circled around several times, "shot up the deck" and made a couple of steep turns, but they refrained from doing the spectacular stunts one has come to expect of smaller jet aircraft of the non-bomber variety. Bad visibility was largely to blame for this "modesty," but it also looked as if at least the pilots of the very new "Espadon" and "Ouragan" were not yet quite, quite certain of what they could do with and to their machines with impunity. This was borne out by the arrival over Orly of Squadron Leader T.W. Wade, Hawker test pilot, in the Hawker P. 1052 swept-wing experimental aircraft which the day before had flown from London to Paris in 21 minutes and now roared across the field in a confident series of slow rolls. Subsequent displays by RAF Gloster "Meteors" and de Havilland "Vampires" looked relatively tame.

Esmeralda, slightly dazed by the objects roaring, whistling, lumbering and flashing through the sky, also wishes to place on record that right at the beginning of the show a large number of French, Dutch, Czech, Italian and American private aeroplanes and trainers filled the atmosphere, with more or less orthodox aerobatics. At the end of the display the U.S. Navy's Lockheed P2V distance-record aircraft, the "Truculent Turtle," staged a spectacular JATO-rocket take-off which nearly stole the show and—despite fly-pasts by formations of USAF Boeing B-29 "Superfortress" and RAF "Lincoln" heavy bombers—made the Navy the most popular foreign armed service at Paris Airport that day.

Exciting it was, says our Favourite Air Hostess, and rendered perfect by the comic relief provided, intentionally or otherwise, by the English-speaking announcer who insisted on mispronouncing the names of the French aircraft types with such a terrific la-di-da accent that Americans and most British no doubt failed to recognise the designations when they saw them in print. At the same time, his French "friend and colleague" proclaimed that no other Englishman spoke French with a better French accent than *his* friend and colleague, the English announcer . . .

The 109-718 Auxiliary Rocket Power Unit

By Heinz Gartmann *

When special units of the Red Army took over the rocket propulsion laboratories of the Bayerische Motorenwerke (B.M.W.) at Baasdorf and Zühlsdorf, two villages north of Berlin, in the early summer of 1945, they discovered one of the most interesting items of German rocket development—the *109-718 auxiliary rocket power unit* designed for the Jumo 004 and B.M.W. 003 R turbo-jet engines. The head of B.M.W.'s rocket development division, Kurt Schnell, was assigned the task of resuming provisional tests, and in collaboration with the firm's chief designer, Werner Singelmann, he succeeded by the end of that summer in building up a complete unit from various old equipment and a number of previously rejected parts, and demonstrating it for the benefit of a group of Soviet engineers and scientists. Much later, towards the end of 1947, a unit unearthed by the U.S. Army at B.M.W.'s Allacher plant was taken to America and subjected to static tests by Air Materiel Command at Wright Field.

Auxiliary rocket power units for assisting take-offs of aircraft with high wing loading were developed and utilised already during the first years of World War II. The initial projects were designed for combination first with reciprocating engines and later with turbo power plants. But even up to 1943, the Germans regarded such units for take-offs and landings as expendable equipment, which should consequently employ the least possible amount of material.

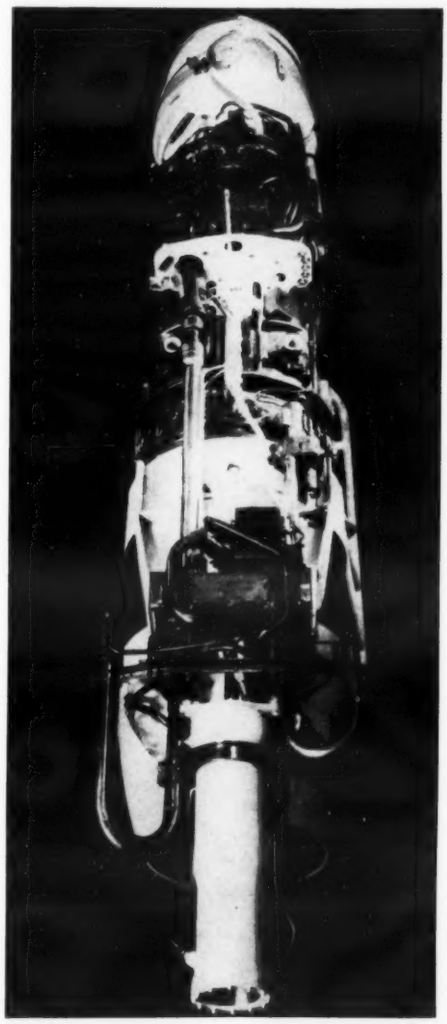
Meanwhile, later experience taught that even rocket units manufactured from cheap materials could be utilised several times, so that the idea arose of devising permanent combinations of turbine and rocket units. In this connection it is possible that the ultimate firm decision was taken in view of the relatively small thrust furnished by the Jumo 004 and B.M.W. 003, two turbo-jets which the Germans developed to combat level of perfection. Thus, towards the end of 1943, the German Air Ministry ordered the B.M.W. power plant division, then headed by Bruno Bruckmann, to develop an auxiliary rocket power unit capable of furnishing 1,500 kgs. thrust, the pump of which should be driven by a turbine engine. The project was given the factory designation P 3395, and the temporary official code number 109-718.

* Mr. Heinz Gartmann, who is now the Scientific Head of the German *Gesellschaft für Weltraumforschung e. V.*, the newly established Society for Interplanetary Research, in Stuttgart, played an important part in the development at B.M.W. of the 109-718 auxiliary rocket power unit. He conducted the experiments with the combustion chamber and was responsible for the utilisation of dural as structural material in conjunction with fuel film cooling.

The B.M.W. rocket engineers, working at Spandau and Zühlsdorf, near Berlin, were able to use the experience gained previously with the 109-510 unit,[1] a rocket motor using a propellant combination with nitric acid as oxidiser, designed for the Me 163 B aircraft. Although this unit was never put into service, and could not be regarded as fully developed until the end of 1944, its most important elements—the combustion chamber, fuel pumps and fuel valves, which had been certificated by the Air Ministry—were nevertheless available. Since the B.M.W. programme provided for the exclusive use of propellant combinations using nitric acid as oxidising component, the new auxiliary unit was designed for a spontaneously ignitable bipropellant containing the afore-mentioned agent.

1 Not to be confused with the production-model rocket motor powering the Me 163, the Walter 109-509 using concentrated hydrogen peroxide as oxidiser, and a combination of methyl alcohol, water and hydrazine hydrate as fuel.—Ed.

Complete assembly of B.M.W. 109-003 turbo-jet with 109-718 auxiliary rocket unit



Manner of function

Being purely a booster unit, the 109-718 was classified under the heading of auxiliary rocket motors. The two fuel pumps are driven through a reduction gear train by the turbine engine. The rocket part is connected to the turbo-jet by means of a universal shaft and an electro-hydraulically driven disc friction clutch. The maximum speed of 21,000 r.p.m. is attained two to three seconds after the clutch has engaged.

When starting the motor, the shut-off valves located between the pumps and the combustion chamber are first of all closed. During this time the propellant amount supplied by the pumps returns via spring-loaded overflow valves to the propellant tanks. The pump discharge pressure, which augments with the r.p.m., works on two pressure-operated contacts which, at 8 atm., close an electrical circuit and thereby open the solenoid valves. The propellants immediately enter the combustion chamber and ignite of their own accord. As the r.p.m. increases, the thrust augments to its maximum value. The overflow valves, which can be adjusted during a small number of test runs, act as governors, limiting the injection quantity and keeping the mixture ratio constant.

When the clutch is disengaged the r.p.m. falls rapidly to zero. As the pump discharge pressure drops, the pressure-operated contacts interrupt the electrical circuit; the shut-off valves, however, cut off the propellant supply at a discharge pressure which still allows for a gradual cessation of the combustion.

The combustion chamber

As stated above, the parties responsible for developing the 109-718 auxiliary rocket unit were straight away able to avail themselves of the operationally-reliable combustion chamber of the 109-510 unit. The only conversion necessary was dictated by the change of propellant combination employed —instead of the non-spontaneously ignitable

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combination of white fuming nitric acid and methyl alcohol, the spontaneously ignitable combination of nitric acid and Tonka (collective designation for various fuel combinations) was used.

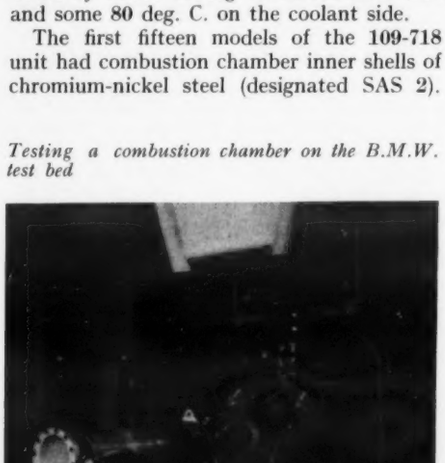
After a number of unsuccessful tests, the head of the original impinging-stream, eight-hole injector was replaced with a new type having simple hole-type nozzles without locking device. This version has 60 holes for admitting the oxidiser and 30 for the fuel, so that to each fuel nozzle there are two oxidiser nozzles. The propellant constituents meet at 4 mm. from the injector plate and spontaneous ignition follows. The nozzles are arranged in two rings and so inclined that the propellant streams lie along the surface of a cone and impinge at a common point of intersection approximately in the centre of the combustion chamber.

The volume of the combustion chamber was somewhat reduced owing to the fact that the injector head, instead of forming a hollow space as it did in the case of the combustion chamber of the 109-510 unit, now extended some distance into the combustion chamber. The exhaust nozzle, originally of 57 mm. diameter, was enlarged, first to 67 mm., and in a later version to 64 mm., in order to reduce the combustion chamber pressure and thereby cut down the mechanical and thermal stress. As, besides this, developmental difficulties of a fundamental nature were feared, the required thrust of 1,500 kgs. was initially decreased to 1,000 kgs. When subsequent experience revealed these fears to have been unfounded, the thrust could be stepped up to 1,200 kgs. without altering the construction in any way.

The original forced-circulation cooling system, consisting of two coolant coils located between the inner and outer shells of the combustion chamber, was replaced with a simple 1-mm.-wide jacket running round the inner shell. In this way the wall temperature at the heaviest-stressed cross-section of the combustion chamber was cut down by about 60 deg. C. on the flame side and some 80 deg. C. on the coolant side.

The first fifteen models of the 109-718 unit had combustion chamber inner shells of chromium-nickel steel (designated SAS 2).

Testing a combustion chamber on the B.M.W. test bed



Later models were equipped with inner shells of dural, resulting in a considerable saving in weight and, what is more remarkable, a lengthening of the combustion chamber's life. Long duration tests even showed the light-alloy version to be much superior.

As in previous rocket designs, the oxidiser was employed as coolant. Nitric acid as a coolant is superior to both methyl alcohol and Tonka combinations. Besides this, it is available in large quantities, as the combination ratio is about 2 : 1 for the non-spontaneously ignitable bipropellant, but must amount to at least 3.5 : 1 for the spontaneously ignitable preparation. Nevertheless, it was not possible to obtain reliable results solely with exterior cooling of the combustion chamber. After more than 80 chambers had been used up in systematic tests, the need for additional cooling could no longer be overlooked.

Apart from enriching the combination with more fuel, another means of achieving adequate cooling action was offered by the method of " film cooling " suggested earlier by Professor Oberth. The additional introduction of nitric acid out of the cooling jacket increased the hazard of excessive corrosion in the narrowest cross-section where the thermal stresses are highest. Meanwhile, the simple and exceptionally effective solution provided by Tonka film cooling made it possible, indeed for the very first time, to employ, inside a light-alloy combustion chamber, nitric acid in spontaneously ignitable combination.

Additional holes were bored in the outer surface of the injector head so that the Tonka constituents could be squirted into the 1-mm.-wide slot between the head and the inner shell. This first of all caused a considerable change in the mixture ratio. With the specific propellant consumption in mind, in order to keep this ratio near to the stoichiometric value, the injector holes for the nitric acid had to be widened. This ultimately gave rise to a double combination ratio. The injector plate alone supplied 6.3 times more nitric acid than fuel into the combustion chamber. Due to the Tonka film, whose share amounted to about 45 per cent. of the entire fuel quantity, the ratio turned out at 3.5 : 1.

Since the designers had succeeded in replacing all the steel parts, except for a few bolts, of the injector end with light-alloy components, the weight of the combustion chamber was decreased appreciably and, moreover, the production prospects improved. In this way the combustion chamber of the 109-718 became the most promising and versatile combustion chamber to emerge from German rocket development.

Table I : Development of the combustion chamber for the 109-718

	Test series	Prod. series	109-510
Steel parts (kgs.)	15.676	0.861	15.68
Dural parts (kgs.)	9.245	11.910	9.245
Total weight (kgs.)	24.921	12.771	24.925
Thrust (kgs.)	1,000	1,000	1,500
Consumption (kgs./tn. sec.)	5.2	5.0	5.6
Weight : thrust (kgs./tn.)	24.9	8.5	16.6

Other components

The turbo-jet's speed of about 8,000 r.p.m. was brought to 21,000 r.p.m. by a gear train. The propellant pumps were taken over from the 109-510 unit. The main difficulty of the latters' development lay in their reliable sealing against the propellants, notably in order to protect the ball-bearings of the nitric acid pump against corrosion. The best solution was found to be a sealing system which was lifted off by centrifugal force when the unit was operative.

As the centrifugal pumps themselves provided no suction, there had to be a minimum feed pressure of 30 to 40 mm. positive head in order to assure an even flow. Cavitation phenomena in the propellant flow passage were eliminated by additionally installing booster pumps.

The propellant valves were made to open against the direction of flow, in order to prevent any unintentional release of propellants. Thanks to a suitable design of opening lever, the fuel was allowed to enter the combustion chamber a little earlier than the oxidiser, so that a safe initiation of the ignition was assured. If the nitric acid was unintentionally allowed to enter before the fuel, violent combustion occurred, in some instances resulting in explosions.

Thanks to a simplified arrangement of the conduits, the entire apparatus was conveniently compact. It took up little space and could easily be interchanged. A general overhaul was necessary after a total running time of one hour, *i.e.*, after twenty starts. The propellant supply provided for three minutes of operation at maximum thrust. The components could be checked after each operation, though this was not absolutely necessary.

In view of the absence of an integral pump drive, the weight of the otherwise self-contained unit was low.

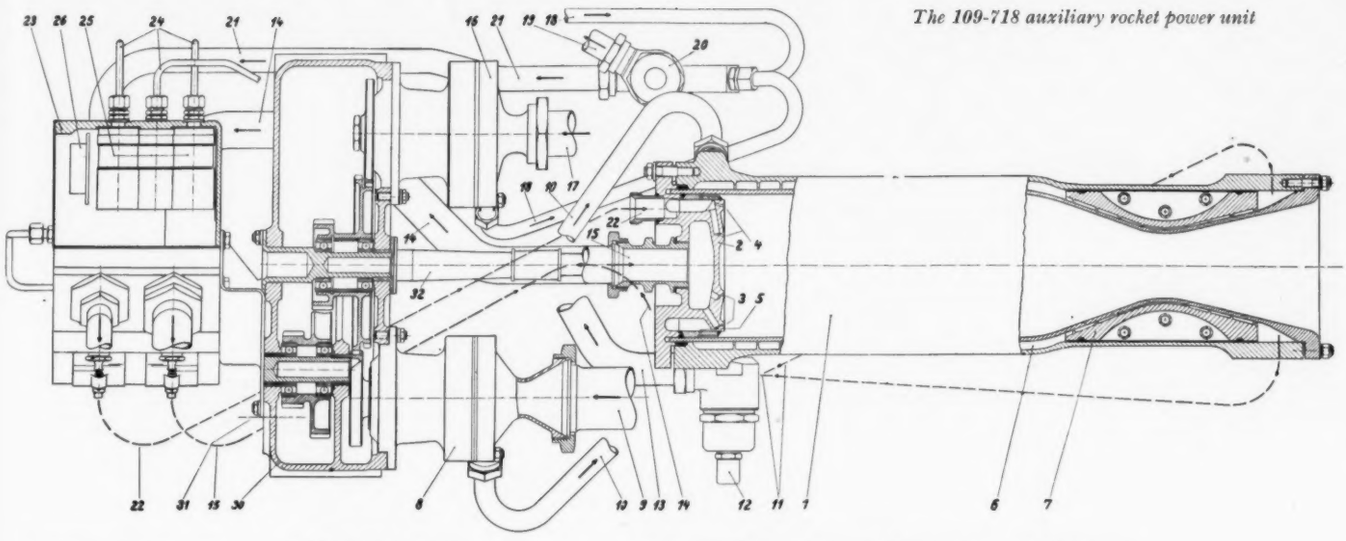
Table II : Weights of the 109-718 unit

	Test series	Prod. series
Combustion chamber (kgs.)	25	12.77
Pumps, gears, valves (kgs.)	33	33
Conduits (kgs.)	13	10
Overflow valves (kgs.)	1	1
Total weight (kgs.)	72	46.77
Weight : thrust (kgs./tn.)	72	31

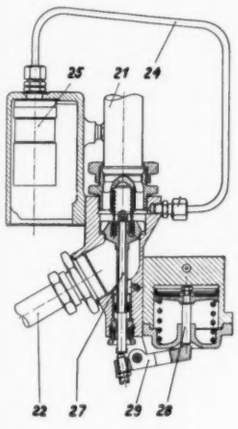
The propellants

The choice of propellants is of the greatest importance in connection with all non-expendable rocket units, thus those which have to be tanked several times. The agitated course of the war called for a restriction to very few and, if possible, only one propellant combination. Besides this, the German manufacturers were constantly faced with a dearth of suitable raw materials, so that they often had to resort to compromises—in rocket development as in all other fields. Whether hydrogen peroxide was or was not a more advantageous alternative to nitric acid, was never fully decided even by the end of the war. Right from the beginning of the war, the military people had worked with hydrogen peroxide and experienced no

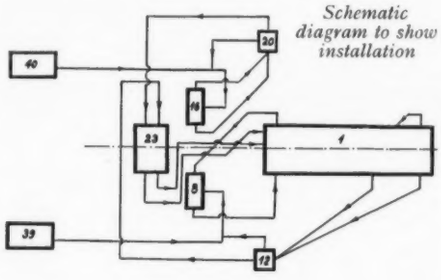
The 109-718 auxiliary rocket power unit



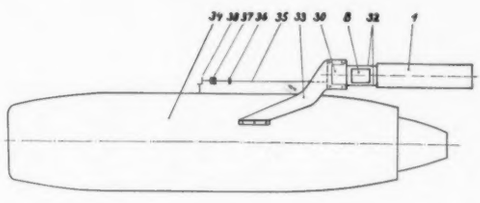
1 Combustion chamber
2 Injector head
3 Nitric acid injection nozzles
4 Fuel injection nozzles
5 Injection nozzles for fuel film (inner cooling)
6 Coolant conduit for combustion chamber
7 Filler block for coolant feed
8 Nitric acid pump
9 Suction conduit of nitric acid pump
10 Pressure conduits for nitric acid
11 Back-flow conduits
12 Overflow valve
13 Overflow conduit
14 Nitric acid conduit to propellant valve
15 Nitric acid conduit to combustion chamber
16 Fuel pump
17 Suction conduit for fuel
18 Pressure conduits to overflow valve for fuel
19 Overflow conduit for fuel
20 Overflow valve for fuel
21 Fuel conduit to propellant valve
22 Fuel conduit to combustion chamber
23 Propellant valve block
24 Regulating conduits
25 Pressure contact
26 Relay box
27 Shut-off valve
28 Piston
29 Rocking arm
30 Gearbox for pump drive
31 Gear engagement
32 Combustion chamber supporting strut
33 Supporting bracket
34 Turbo-jet engine
35 Driving shaft
36 Universal joint
37 Clutch
38 Bevel gear
39 Nitric acid tank
40 Fuel tank



Propellant shut-off valve



Schematic diagram to show installation



Manner of fixing it to the turbo-jet

trouble. The limited possibilities of its production, however, made it necessary to change to 98-99 per cent. pure nitric acid, a colourless to yellowish liquid giving off pungent fumes. A powerful oxidiser, it occasions severe burns upon contact with organic matter; diluted with water it dissolves even iron very quickly. Stainless steel and light alloys—particularly pure aluminium and dural—are less liable to corrosion. The main disadvantage of nitric acid is its liberation of toxic vapours, but it offers the advantage of favourable handling and storage characteristics.

Nitric acid and methyl alcohol were employed to constitute a non-spontaneously ignitable bipropellant for the 109-510 unit. The combination was ignited chemically by adding small quantities of spontaneously ignitable liquids prior to injection.

The fuels which were combined with nitric acid as oxidiser were collectively designated "Tonka" and also received a number which characterised the precise composition. The Tonka 250 combination reacted as spontaneously ignitable when combined with pure nitric acid; the 93, 50 and 505c combinations also reacted, but with a noticeable ignition delay, which was rectified by adding 4 per cent. by weight of iron trichloride to the nitric acid. The best combustion was obtained with Tonka 250. This is an organic amine combination of basic character, which cannot be mixed with water and is recognisable by its clear yellow to brown colour and naphthalene-type odour.

Tonka 250 is composed of 50 volumes of crude xylidine F and 50 volumes of triethylamine. The Tonka 93 combination is made up from crude xylidine (20), aniline, monomethylaniline and dimethylaniline (20), ethylaniline (20), isohexylamine (20), heavy gasoline (10) and solvent-type benzene (10). The 500 combination is of similar composition. (The numbers in parentheses indicate the volume parts.)

The installation of the auxiliary rocket unit made it necessary to equip the aircraft with tanks for the nitric acid and the fuel mixture. In order to economise at least one tank, extensive tests were conducted with a view to using the turbo-jet's fuel also as fuel for the rocket unit. However, the attempts to make this fuel self-reacting with nitric acid, by adding catalysts, were unsuccessful. Experiments involving chemical ignition of the combination led without exception to the destruction of the combustion chamber by explosion.

Development history

The 109-718 auxiliary unit was developed within an exceptionally short time, and alongside the rocket unit built for the X-4 winged bomb (also B.M.W.), represents the most carefully and highly perfected German rocket power unit using nitric acid as oxidiser. Installation difficulties delayed the actual flight tests. The entire developmental programme proceeded without any really serious accident, though the combustion chamber, due to careless handling, exploded during the first static test in an aircraft at Lechfeld air base, near Augsburg. The first flight test was made on March 28th, 1945, at Lechfeld, when the rocket unit was not started for the take-off, but only once the aircraft was on the wing. After two flights, the turbine engine had to be changed — and Germany's capitulation marked the end of the development story.

The Laws of Motion in Space Travel

By Dr. EUGEN SAENGER, Paris

On February 24th, 1949, U.S. Army Ordnance engineers at White Sands Proving Ground, New Mexico, fired a two-step rocket to 400 kilometres (250 miles) altitude, thus beyond the earth's gaseous atmosphere. The "booster" step was a V-2 and the rocket proper, a "WAC Corporal," which attained a maximum velocity of 8,000 kms./hr. (5,000 m.p.h.). Roughly at the same time, a little news seeped through with respect to the immediate goals of the U.S. Earth Satellite Vehicle Programme : airspace supervision, meteorological research, the establishment of automatic microwave relay stations for various purposes, notably including the guiding of long-range missiles. Ultra-short waves—such as those used in television, for example—cannot follow the earth's curvature, so that an artificial satellite orbitting around the earth could perform valuable duties. The investigations of Dr. Eugen Saenger, an internationally-known rocket expert, may help to clarify many of the problems arising in this connection.—Ed.

We begin to speak of the space trajectories of rockets once the air density—and consequently the dynamic pressure—during the course of the trip has become so feeble that, even at extreme velocities (*e.g.* 12,000 m./sec.), the trajectory is no longer noticeably affected by aerodynamic forces. This is the case when the dynamic pressure has fallen below about 1 kg./sq.m.

Fig. 1 shows the dynamic pressure plotted against the altitude for a number of extreme velocities. The aerodynamic forces—drag and lift—practically disappear at altitudes above 100 kms. A very large fraction of the trajectories of ascent and supersonic descent of present-day rockets, therefore, lies in a medium which is practically a vacuum.

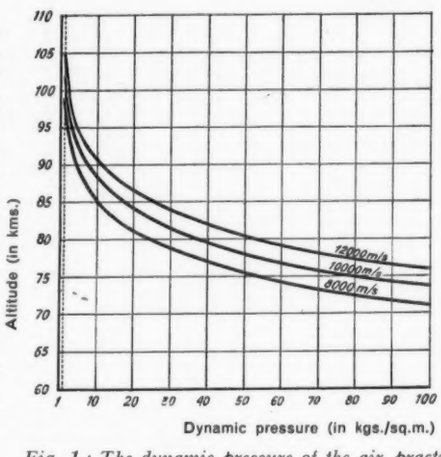


Fig. 1 : The dynamic pressure of the air practically disappears at altitudes of over 100 kms.

Beyond this 100-km. "frontier" aeronautics goes over to astronautics. What could previously be called "flight" becomes a free, planetary-type kinetic motion, which can no longer be governed in any way by lifting and control surfaces, but requires guidance in the form of auxiliary rockets or devices for varying the direction of the escaping exhaust gases. The occupant of such a spaceship would no longer feel the effects of terrestrial gravity, and would live under conditions of complete weightlessness, with gravitation and centrifugal force in equilibrium.

The motion of a spaceship with its reaction power unit inoperative can be calculated from the well-known Laws of Planetary Motion. Fig. 2 shows various conceivable trajectories passing through a point *A* situated at over 100 kms. distance from the surface of the earth. Depending on its angle and velocity of departure from point *A*, the spaceship will follow different conic sections : a straight line (vertical) ; a family of "ballistic parabolas," which, in view of terrestrial gravity concentrated in a single point, are really ellipses ; a circle with its centre coincident with that of the earth ; ellipses again ; and finally parabolas or hyperbolas. The centre, or one of the foci, of these conic sections always coincides with the centre of the earth. One of these trajectories is shown in Fig. 3.

The data of the space trajectory are :—

A to earth's centre	$r_A = R_o + h$	(metres)
Velocity at A	v_1	(m./sec.)
Directional angle	ϕ_A	(degrees)

These suffice to enable the form and position of the conic section to be determined. The latter depends on the following parameters :—

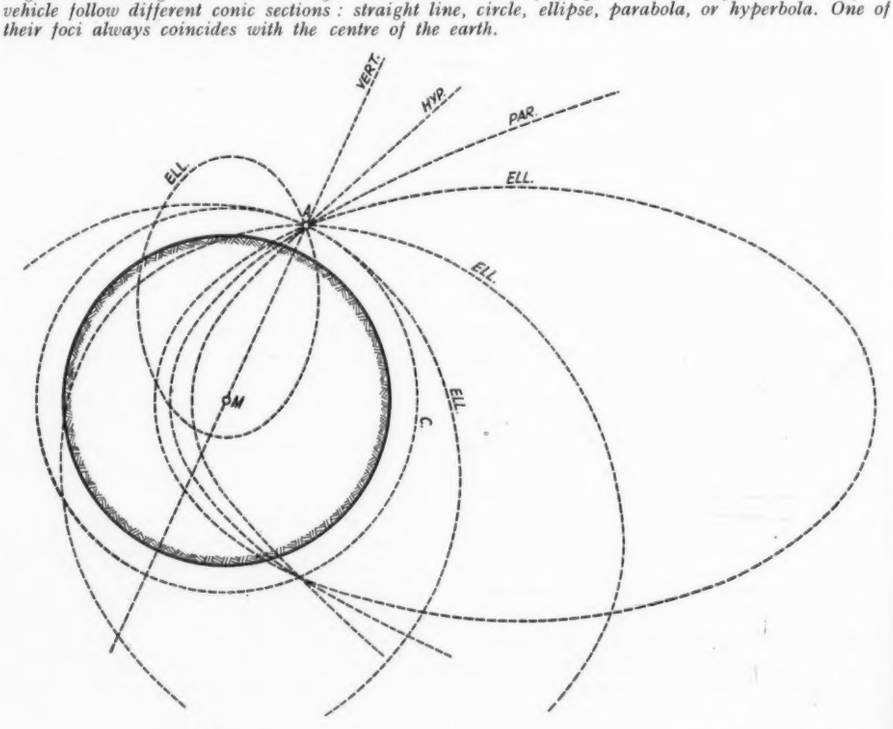
Major axis of the trajectory	a	(m. or km.)
Minor axis of the trajectory	b	(m. or km.)
Angle of orientation	β_A	(degrees)

The calculation is effected with the aid of three equations :—

(1) Polar equation of the ellipse :

$$r_A = \frac{b^2/a}{1 + \frac{\sqrt{a^2 - b^2}}{a} \cos \beta_A}$$

Fig. 2 : According to the initial angle and initial velocity, from point A, the trajectories of a space vehicle follow different conic sections : straight line, circle, ellipse, parabola, or hyperbola. One of their foci always coincides with the centre of the earth.



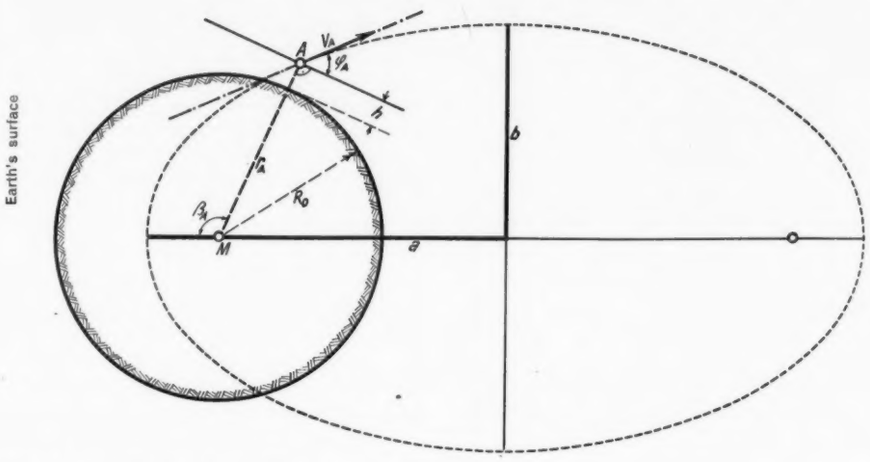


Fig. 3 : Coordinates of an elliptical space trajectory.

(2) Geometric relation between the directional angle and the other parameters of the trajectory :

$$tg\,2\phi_A = \frac{2\sqrt{a^2-b^2}\,\sin\beta_A}{r_A+2\sqrt{a^2-b^2}\,\cos\beta_A}$$

(3) First equation of Binet :

$$v_1^2 = g_0 R_0^2 \left(\frac{2}{r_A} - \frac{1}{a}\right)$$

The third equation is nothing but a particular formulation of Kepler's Third Law of Planetary Motion, whereby the radius vector (r_A), joining the centre of attraction and the centre of the mobile object, sweeps over equal areas in equal periods of time. From this it can be seen that the length of the major axis of the spatial trajectory depends solely on the initial velocity prevailing at point A.

The three equations are interpreted in Figs. 4 to 6 for a point of departure A which is situated at a distance above the earth's surface amounting to 100 kms. more than the mean radius of the globe (R_0 = 6,370 kms.), so that its distance from the centre of the earth may be written r_A = 6,470,000 metres. The initial velocity v_1 at point A will vary between 0 and 12,000 m./sec., and the directional angle ϕ_A between −90 deg. and +90 deg.

Fig. 4 shows how the major axis of the ellipse, a, depends solely on the initial velocity v_1. At the so-called " circular velocity " (7,840 m./sec.) the major axis of the ellipse becomes equal to r_A (6,470 kms.) ; meanwhile, the minor axis of the ellipse, b, is also dependent on the directional angle ϕ_A, as Fig. 5 reveals, and consequently becomes equal to r_A only when the directional angle is exactly equal to 0 deg. In this case the elliptical trajectory goes over to a circular trajectory —an occurrence which can be deduced in a very simple manner by postulating that the centrifugal force must balance the force of terrestrial attraction :—

(4) $$\frac{v_1^2}{r_A} = g_0 \frac{R_0^2}{r_A^2}$$

$$v_1 = R_0\sqrt{\frac{g_0}{r_A}} = 6{,}370{,}000\sqrt{\frac{9.81}{6{,}470{,}000}} = 7{,}840 \text{ m./sec.}$$

The equation of Binet, of course, furnishes the same result if we set a equal to r_A.

A further characteristic velocity featured in Figs. 4 and 5 is the so-called " escape velocity." It is always $\sqrt{2}$ times greater than the circular velocity since, according to equation (3), for an infinitely long major axis, *i.e.* for the value $1/a = 0$, we may write :—

(5) $$v_1^2 = g_0 R_0^2 \frac{2}{r_A}$$

$$v_1 = \sqrt{2}\, R_0 \sqrt{\frac{g_0}{r_A}} = \sqrt{2}\ 7{,}840 = 11.060 \text{ [m/sec.}$$
$$a = b = \infty$$

The ellipse has become a parabola ; therefore, as Fig. 5 shows, the " minor axis of the trajectory " also becomes infinitely large for *all* directional angles. In consequence, outside the atmosphere, if the escape velocity is attained along *any* direction leading away from the earth, the latter will be abandoned permanently by the vehicle ; the position and form of the parabola naturally depend on the directional angle. If the velocity increases still further, the trajectory goes over to a hyperbola, whose major and minor axes may again be determined with the three afore-mentioned equations, these being suitably modified.

The family of curves for the angle of

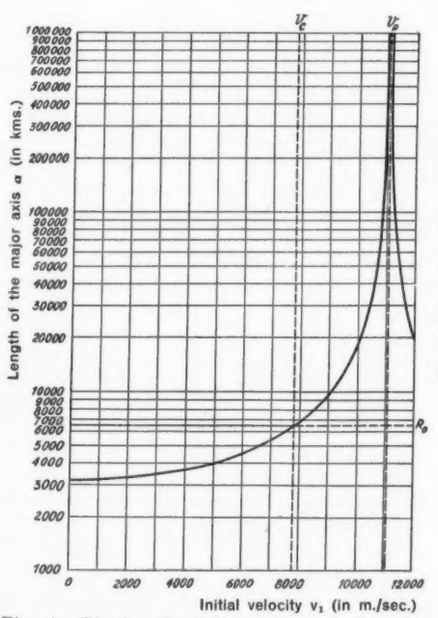


Fig. 4 : The length of the major axis (a) *of a space trajectory depends only on the initial velocity.*
v_C = circular velocity
v_p = parabolic velocity (escape velocity)

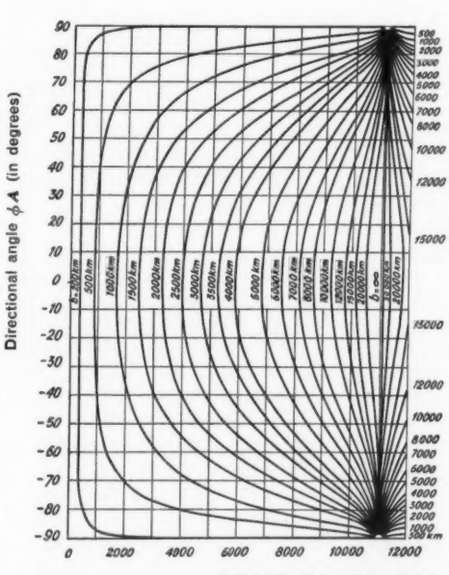


Fig. 5 : The length (b) *of the space trajectory's minor axis depends on the initial velocity and the directional angle.*

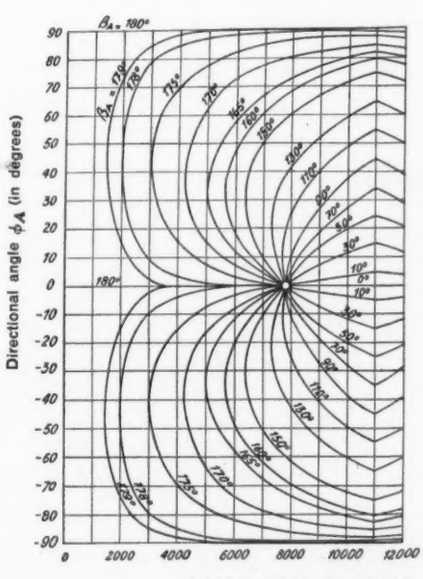


Fig. 6 : The space trajectory's angle of orientation (β_A) *depends on the initial velocity and the directional angle.*

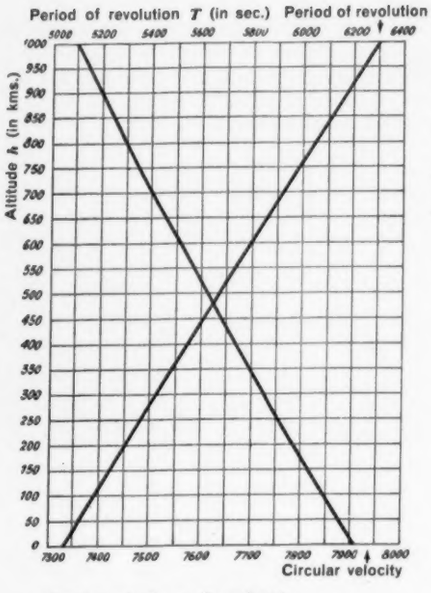


Fig. 7 : Circular velocity and period of revolution around the earth in the case of a circular trajectory.

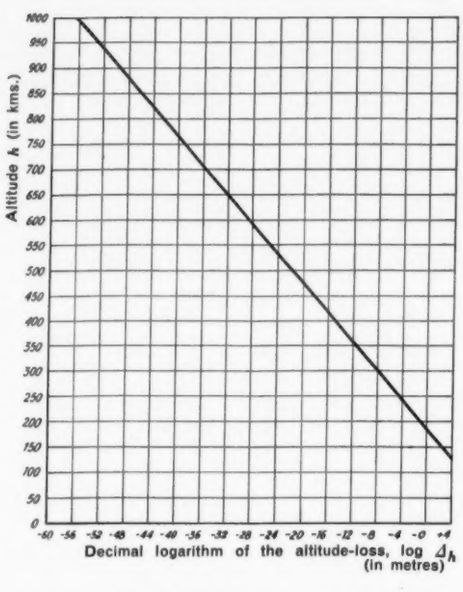


Fig. 8 : Altitude-loss (Δ_h) per revolution around the earth for a 10-tonne space vehicle orbitting at an altitude h *at circular velocity and being subjected to the drag of the thin upper air levels.*

orientation of the spatial trajectory (Fig. 6) features one single point for the directional angle $\phi_A = 0$ and the circular velocity (7,840 m./sec.), because the angle of orientation of a circular trajectory is, by nature, undefined. At the escape velocity (or parabolic velocity) the angle of orientation is always equal to twice the directional angle.

With regard to " earth satellite stations, " inhabited or not, the most interesting aspect is the circular trajectory around the earth at an altitude of over 100 kms. This enables a spaceship to gravitate *ad infinitum* around the earth, at extreme altitudes and without propulsion.

For $R_0 = 6{,}370$ kms. and $g_0 = 9.81$ m./sec.^{2}, we can derive from equation (4) the values of the circular velocity for various altitudes h in respect of the values plotted in Fig. 7. The latter diagram also presents the curve of the period of revolution T of the satellite gravitating about the earth ; this curve can be calculated by means of the equation :

$$T = \frac{2\pi (R_0 + h)}{R_0 \sqrt{g_0/(R_0 + h)}} = \frac{2\pi}{R_0 \sqrt{g_0}} (R_0 + h)^{1.5} \quad (6)$$

For one single revolution it is generally permissible to ignore the effects of the minimal aerodynamic forces on the trajectory. If, however, the rotation about the earth is pursued, then these effects add together and eventually assume considerable importance.

In first approximation the altitude-loss per revolution, Δ_h, can be calculated by making the difference between the reduction in potential energy (of position) and the increase in kinetic energy (of motion) equal to the work of the air drag per revolution. The numerical values naturally depend on the form and weight (mass) of the spaceship. For a given example, a spaceship weighing 10 tonnes (10,000 kgs.) and having the form shown in Fig. 34 of the writer's article, " The Prospects of Jet Reaction Flight, "[1] this altitude-loss per revolution amounts to :

at 130 kms. altitude, *c.* 10,000 m. per rev.

at 180 kms. altitude, *c.* 1 m. per rev.

at 1,000 kms. altitude, *c.* 3.10^{-57} m. per rev.

These values of altitude-loss per revolution are plotted—to logarithmic scale—versus altitude in Fig. 8.

Influenced by the air drag, the " space-station " therefore departs from its orbit and spirals towards the surface of the earth. If the initial altitude is 130, 180 or 250 kms., it loses one per cent. of this altitude in $^1/_8$, 1,800 or 100,000,000 revolutions, respectively. Already at an altitude of little more than 200 kms., the spacestation would gravitate around the earth like an artificial satellite, and maintain its orbit *ad infinitum* (according to the human time scale) without further propulsion.

Experiments have shown that such initial altitudes are attainable today. But the realisation of an adequate circular velocity (of the order of 7,750 m./sec., according to the initial altitude ; see Fig. 7) is a problem apart. The highest velocity so far reached with a step rocket is only just about one third of this value. However, by adding more steps to the rocket, and above all by augmenting the exhaust velocity, we should be able to reach such a circular velocity in the not-too-distant future. Meanwhile, let us first rapidly consider the theoretical fundamentals of this problem :

A *single-step* rocket which, for the duration of its combustion, continuously ejects fractions (dm) of its total mass (m) rearwards with the exhaust velocity c, and thereby reduces its own mass and increases its own velocity (v), works according to the differential equation for momentum (Newton's second and third Laws), expressed here as follows :

$$m\ dv + c\ dm = 0$$

This differential equation yields the final velocity v_1, attained once the combustion has been completed, by integrating dv between the limits : initial mass m_0 (at $v_0 = 0$) and final mass m_1 :

$$v_1 = c\ \log_e \frac{m_0}{m_1} \quad (7)$$

or, in a technically more usable form, by introducing the weights in place of the masses :

$$v_1 = k\,c\ \log_e \frac{G_0}{G_1} \quad (8)$$

Here, G_0 signifies the take-off weight, G the end weight, and $k < 1$ a factor which accounts, summarily, for the partial utilisation of the thrust to overcome aerodynamic and gravitational forces.[2]

In the case of *multi-step* rockets, the attainable velocity of the final rocket step is given by the sum of the various steps' velocities.

Meanwhile, these equations bring to light the great importance of increasing the exhaust velocity (c) as much as possible, in order to keep the mass-ratio of the final rocket ship (which would be the satellite proper) to the initial—eventually composite—rocket within technically and economically reasonable limits. The highest effective exhaust velocities attainable today are probably 2,500 m./sec. with alcohol-oxygen medium-pressure rockets, and 3,500 m./sec. with hydrocarbon-ozone high-pressure types. It may be expected that exhaust velocities of up to 10,000 m./sec. will be attainable with atomic rockets using hydrogen as working fluid.

Then, another tricky problem arises : that of guiding the vehicle at an angle of exactly 0 deg. once it has reached the circular " flight " trajectory, which, as we have seen, is a *sine qua non* for obtaining a circular trajectory. The rocket will have to be deviated from its ascending trajectory to the circular trajectory without exceeding a certain acceleration due to centrifugal force ; or kept at constant altitude, at the apogee of its elliptical trajectory, during its re-acceleration. Technically, this should be realisable by means of guidable jet streams and gyroscopes ; and eventually with the aid of automatic devices for measuring the angles of azimuth and relative bearing, with rocket-borne electronic computing equipment, using a ground omni-directional radio beacon as reference. Cutting out the rocket motor at the moment the correct circular velocity has been reached on an exact circular trajectory, would be relatively simple.

An ultra-short-wave set and other radio equipment would enable even an unmanned satellite to enter into radio contact with all ground stations within " line-of-sight distance " as long as its transmission power were sufficient. However, it is likely that many moons will have passed before man inhabits one of his own making.

[1] INTERAVIA, Review of World Aviation, Vol. III, No. 11, p. 619.

[2] INTERAVIA, Review of World Aviation, Vol. III, No. 11 p. 620.

Aircraft Undercarriage Construction

Views on the Rôle of the Undercarriage Constructor in Aircraft Industry.

By René Lucien, Ingénieur E.C.P., F.R.Ae.S., M.S.A.E., M.I.Ae.S., Paris.

The construction of undercarriages has considerably increased in importance since the days of simple shock struts about two decades ago. A modern undercarriage, in view of its complicated retraction mechanism, confronts the aircraft constructor with a plethora of increasingly complex problems —in kinematics, structural location, drag, and so forth—right from the initial project stage.

To what extent can the undercarriage constructor make his knowledge and wide experience available in order to simplify the airframe constructor's task and cut down the development costs ? This is the question discussed in the present article.

Should the undercarriage specialist confine his work to manufacturing aircraft parts, for whose general design, calculation and strength characteristics the airframe constructor is responsible ? Or should he, on the contrary, act as a sort of consulting engineer at the disposal of the airframe constructor, and assume full responsibility for the design, calculation and testing of undercarriages ? Up to the present, these questions have been answered, it would seem, in basically different manners in the U.S.A. and Europe, and it is interesting to fathom these divergencies and compare the results achieved.

The Americans were quick to realise that the magnitude and multiplicity of the problems which had to be solved industrially, must lead to a concentration of the specialised manufacturing facilities necessary for undercarriage construction. Thus we find, in the entire U.S.A., only three manufacturers of large undercarriages : Cleveland Pneumatic Tool, Bendix, and Menasco. To the best of our knowledge, firms such as Adel and Electrol have hitherto confined themselves to making parts for retraction mechanisms and to undercarriages for light aircraft. And in all instances where such firms have manufactured entire undercarriages, the latters' design seems to have been the concern of the aircraft manufacturers, who furnish the specialised firms with blueprints which nevertheless provide for the incorporation of individual parts already designed and calculated by these firms. Even in the case of aircraft as large as the Consolidated Vultee B-36 long-range bomber, for example, we find that the manufacture of the main landing gear was entrusted to Cleveland Pneumatic Tool, whilst Bendix built the nose-wheel assembly.

In our opinion, a method such as this has certain inconvenient aspects. We find in every major aircraft firm a good hundred engineers and designers who devote their time to examining undercarriages and hydraulic apparatus, although actually not a single one of these units is manufactured by their own firm. Therefore, this team accomplishes, for about six or seven prototypes annually, pre-determination work which has subsequently to be completed by specialised manufacturers ; the team then has to execute the assembly of all these elements in order to check their function in conjunction with the aircraft. In consequence, it sometimes strikes the outside observer that the hydraulic installations of U.S. aircraft do not appear to embody that degree of unified conception which would seemingly favour a good final result.

Thus we find examples of one single aircraft featuring hydraulic and electrical servo controls which both cope with identical tasks. Then, the adaptation of individual hydraulic elements to assemblies of which the flow quantities have already been determined, can be effected only empirically and must be coupled with uncertainty. The result is that the aircraft constructor, having become the conductor of a large orchestra of suppliers, has to acquire very extensive testing facilities in order to make sure the entire assembly functions reliably. For perfecting the hydraulic equipment of the Lockheed " Constitution " (184,000 lbs. gross weight), for example, a full-scale test rig was built, comprising the entire undercarriage and its retraction mechanism, cowlings and accessories, as well as the servos for the control surfaces. This installation cost the U.S. Navy around one million dollars, but it enabled—after a few hundred tests—an extremely high level of perfection to be attained from a very complex assembly.

We in Europe have the greatest admiration for the extreme care which the Americans devote to such tests. Nevertheless, we think that such tests, if executed under the control of the constructor of the undercarriage and hydraulic equipment, thus the firm responsible for the entire mechanism, would enable this firm also to benefit, for the sake of all its customers, by the extremely expensive experiment which must inevitably be repeated for each aircraft type and on the premises of each aircraft constructor. Besides this, the fact that the undercarriage constructors are isolated from the problems belonging to the aircraft proper, can hardly arouse in them the tendency, which they should have, to interest themselves not only in their material in itself, but also in the reactions of this material in relation to the entire aircraft. It seems, from as much as we have been able to observe, that the undercarriage constructor who, in the U.S.A., has fulfilled on a suitable test rig the dynamic test conditions demanded in the aircraft constructor's load chart, has not to concern himself with conditions which may seem accessory, but with conditions, such as taxiing, which are directly connected with the life of the assembly and the safety during take-offs and landings. And how could he do so anyhow, since, as we have already explained above, in certain instances he finds himself assigned the execution of only a part of the assembly, the other parts being constructed by his competitors ?

Therefore, we think that the European method, which consists in asking the undercarriage constructor to act as a sort of paid consulting engineer to the aircraft manufacturer, is preferable to the U.S. method, though provided the undercarriage constructor is assured of access to all the means enabling him to make his customers benefit by all the experience gathered through extremely extensive tests.

On the other hand, the trend, presently being followed in France, to have the studies and tests executed on a general basis by a professional association grouping all the national manufacturers of undercarriages, is

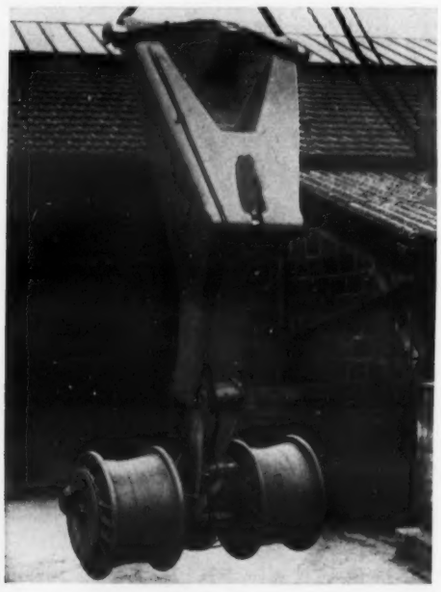
Fig. 1 : Drop tests of the Convair B-36's main undercarriage, a welded steel construction of Cleveland Pneumatic Tool Co. Electric motors are used to rotate the wheels prior to their impact with the simulated runway, the r.p.m. corresponding to the landing speed.

Fig. 2 : Mr. J. F. McBrearty, Lockheed Division Engineer, demonstrates his drag shock strut installed in the retraction mechanism of the " Constellation " main undercarriage. The undercarriage is built up from swaged elements welded together.

interesting from the economical standpoint : it enables the scale of the means employed to be brought into line with the necessity of restraining the resultant expenses.

What scope, therefore, should be assigned the undercarriage constructor in order that he may work under the best conditions ? It is essential that he be consulted right from the beginning of the project and that he be in a position, through having examined several solutions advanced to a reasonable degree, to guide the aircraft manufacturer towards the most logical solution. In effect, we in Europe have suffered from the disadvantages of our system : the aircraft manufacturer,

Fig. 3 : Main undercarriage of the Bréguet 761 (97,000 lbs.), made up largely from cast light alloy (Messier).



finding himself relieved of all worries relative to the undercarriage, developed a tendency to leave to the undercarriage constructor the job of finding solutions within a scope which was confined by all the other demands of the aircraft construction. The result was that the undercarriage constructor, compelled to tackle almost insoluble problems and having to be content with badly chosen points of attachment, was obliged to propose a mechanism often incurring excessive weight penalties. A number of unfortunate results incited the aircraft constructors to alter their viewpoint and to take account, already during the early design stage, of the conditions required of a satisfactory undercarriage structure. A similar phenomenon arose in connection with the complexity of undercarriages, and we witnessed the birth of a whole series of retractable undercarriage designs incorporating castoring wheels, which were very attractive from the kinematics point of view, but involved complications as regards manufacture and maintenance, which condemned their utilisation. Nevertheless, it is true that in certain cases, and for high-performance aircraft, certain artifices must be resorted to, such as complete retraction, for example. This type of problem is best solved by a single specialist.

The hydraulic installations of an aircraft form a unity. The slightest modification of the system can involve an increase in the volume of fluid necessary for its function. In consequence, this can lead to an increase in the dimensions of the casings, containers and, in certain cases, of the pipe cross-sections. This, too, illustrates the importance attached to a unified and concentrated approach to all the problems involved.

If we now turn to the manufacturing aspects, we observe, between the American and the European techniques, differences arising, on the one hand, from the materials available, and on the other, from the magnitude of the series and the manufacturing delays.

Except for certain aircraft, such as the Lockheed F-80 " Shooting Star " jet fighter, for example, which was realised within the remarkably short time of 140 days, it seems that the U.S. constructors benefit by reasonable time delays for, on the one hand, building the prototype, and on the other, for preparing the quantity-production methods. The immense tooling facilities at the disposal of U.S. manufacturers and, above all, the qualitative constancy of their weldable Ni, Cr and Mo steels have favoured manufacturing methods allowing prototype undercarriages to be machined from forged blocks (Figs. 1 and 2), the series being executed from swaged elements assembled by flash welding or pressure welding. This method, which necessitates extremely careful preparation of the welding operations, enables very compact elements to be manufactured, which, in view of the far-reaching mechanisation of the welding process, minimises the different effects the human factor can have on the final product. Flexional tests and magnaflux examinations offer means of having a guarantee of safety for constructions manufactured in this way. However, long undercarriages manufactured in this manner feature the disadvantage of great flexibility and particular sensitivity to shimmy.

The method most widely used in Europe for the past ten years has been the utilisation of moulded light alloys ; the box structures, taking either a bridge-type form or, more recently, a single-leg structure, were first of all executed in magnesium, and later, when greater loads were imposed, in treated light aluminium alloy (Figs. 3 and 4). This

Fig. 4 : Main undercarriage of the SE 1010, also largely of cast light alloy (Messier).

method, which endows structures with a high degree of stiffness, is, in our opinion, destined to attract new attention with the advent of such alloys as magnesium-zirconium, which possesses substantially improved characteristics compared with earlier magnesium-base alloys. Patterns are very quickly made ; its modification incurs no excessive delay or expense. This method offers attractive prospects with respect to the medium manufacturing series common to Europe.

The habit of the certification authorities to impose considerable safety margins with regard to cast products—and this despite the precautions and verifications demanded of the constructor—will tend to restrain the utilisation of this method, until the day when it will have been recognised that it offers, notwithstanding the eventual presence of certain local defects, high safety qualities,

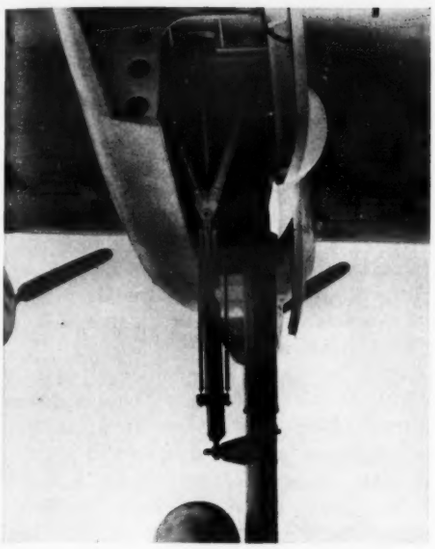


Fig. 5 : Undercarriage of the Bréguet 890 " Mercure " of 35,300 lbs. (box structures and welded tube ; Messier).

notably due to the considerable inertia arising from all box structures. It has nevertheless been necessary, in order to account for these demands, to turn to welded steel constructions, though in accordance with the means at present available in Europe. Thus, the undercarriages of the Bréguet 890 (Fig. 5) and the Morane 700 (Fig. 6) are box structures, built up from modelled sheet-metal parts welded together. This method, in our opinion, requires treatment after the welding, if it is to be reliable ; in the case of large undercarriages, this calls for extensive facilities that are not widely available. We would point out another disadvantage, namely, that it incurs a good deal of manual welding and therefore depends greatly on the workmen's professional skill. This

Fig. 6 : Nose-wheel assembly and a main landing wheel of the Morane 700 twin-engined liaison aircraft (welded sheet-steel semi-coques ; can also be effected with rubber presses), manufactured by Morane.

presents a serious obstacle to serial production ; an obstacle which becomes all the more apparent when we realise that, whereas large series of moulded assemblies can be verified with extensive X-ray facilities combined with analyses of the metal, welded assemblies can only be verified by means of a very rigid control during the actual manufacturing process, as the completed assembly in most cases features numerous inaccessible parts. This is why we think that, if European manufacturers become interested in welded-steel methods, they will have to follow the pattern of American methods and, for that, use grades of steel corresponding to the Ni, Cr and Mo types employed in the U.S.A.

Admittedly, it is frequently possible to save weight by employing forged duralumin sections. These are assembled mechanically at the pivot axes and stiffened by means of elements which are usually also of forged duralumin. These methods, very onerous with respect to the prototype construction, can nevertheless prove interesting as soon as the scale of production enables a reasonable amortisation of the dies to be envisaged. They are widely used in Great Britain, in view of that country's available possibilities of forging light alloys (Fig. 7).

To return to an aspect we briefly mentioned at the beginning of this paper, we do not think the Americans attach special importance to the questions of taxiing and of the shimmy effects which can arise due to bad functioning of the dampers. Indeed, it does not strike us that the U.S. undercarriage designs give, during taxiing operations, a degree of suspension likely to preserve the airframe in good condition and obviate for it the untoward consequences arising from shimmy effects. This opinion is corroborated by certain very extensive studies carried out by Mr. J. F. McBrearty, Division Engineer of Lockeed Aircraft Corp., following some trouble arising in connection with the Lockheed " Constellation " undercarriage, owing to drag oscillatory loads. To rectify this, it was necessary to incorporate a drag strut in the undercarriage (Figs. 2 and 8). Whilst this drag strut is undeniably interesting as regards compensating the initial shock and the oscillations arising from the setting in rotation of the landing wheels, it would nevertheless be interesting to know in what measure one could, in a general manner, diminish the loads transmitted to the structure, simply by improving the quality of the shock absorbing system. This improvement could take its origin in two factors. The first concerns a guiding of the shock strut system ; we in Europe attach great importance to such guiding, and it strikes us that in certain U.S. types it has been approached strictly in terms of the available structural space. The second factor relates primarily to the actual qualities of the shock absorbing system, and to the dispositions made so that it will, on the one hand, not mount too quickly to an extreme coefficient, and on the other, offer good absorbance when a bumpy terrain causes it to undergo rapidly reciprocating movements.

Photographs of undercarriages on the drop-test rig (Fig. 1) clearly show the appreciable flexion undergone before the shock strut begins to be compressed ; these tests usually do not take into account the drag loads due to the speed of the aircraft in practice. In Europe, therefore, various solutions have been suggested, either to obtain a compromise enabling both the landing and the taxiing conditions to be satisfied, or to provide the shock strut with an automatic means of switching over from " landing " to " taxiing. " The Olear system

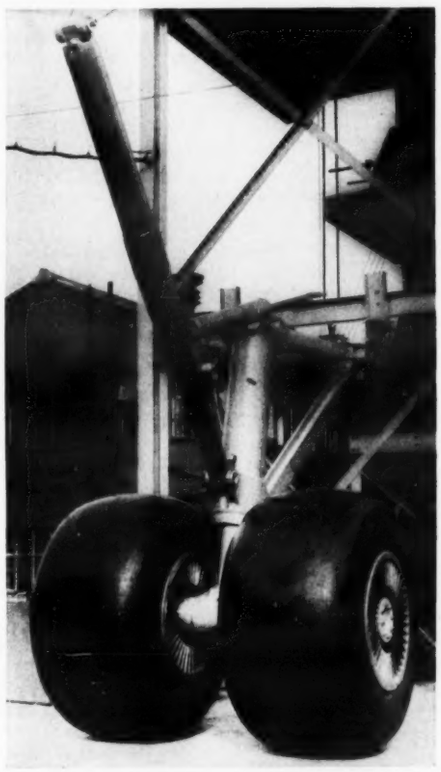


Fig. 7 : British undercarriage constructors have a preference for forged dural sections. This photo shows the main undercarriage (Dowty) of the 308,605-lb. Bristol 167 " Brabazon 1 " airliner.

alters the sections through which the compressed air passes, by means of a device working in accordance with the mechanical friction. The Chausson-Secan system releases a given quantity of oil through a small orifice ; after the impact, this opens valves corresponding to the taxiing. In the Katz system, a valve (which shuts when the shock strut is fully extended) is kept shut during the impact by the pressure arising from this impact ; as soon as the shock strut starts to extend, the drop in pressure allows this valve to open permanently (for taxiing). In conclusion, we might add that the Société

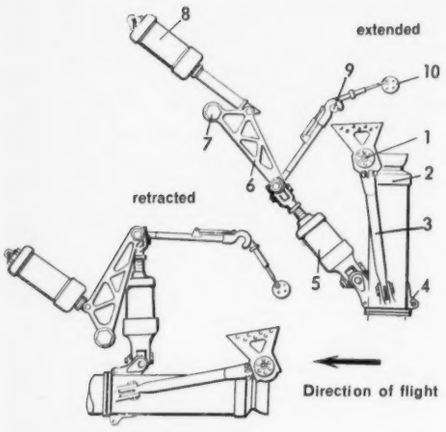


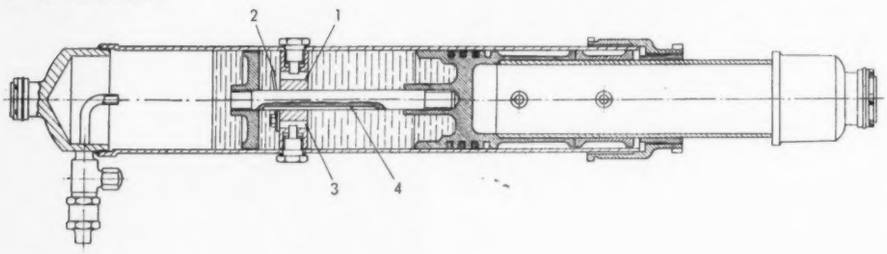
Fig. 8 : Main undercarriage retraction system of the Lockheed " Constellation."

1 Main pivot and support
2 Shock strut
3 Side struts
4 Upper joint of torque arm
5 Drag shock strut
6 Upper drag strut
7 Front pivot
8 Actuating cylinder
9 Down lock strut
10 Lock strut control

Messier has, since the beginning of its aeronautical activity, provided its shock struts with a groove assuring, for the median position of the piston, a regulation allowing for a combination of the supple damping during taxiing with the harder damping required for coping with the actual impact (Fig. 9).

To sum up, therefore, it has been seen that the U.S. procedure places more responsibility on the shoulders of the aircraft constructor and compels him to find simple solutions on his own, without relying exaggeratedly on the ingenuity of his supplier ; this implies a great advantage. The European procedure, taking its roots in a desire to economise which seems to be less widespread in the U.S. aircraft industry, has the advantage of concentrating the experience and research facilities on the doorstep of the specialist and of avoiding an endless repetition of research and perfection expenses for similar problems.

Fig. 9 : Messier shock strut: When compressed, the oil passes through the orifices (1) and (3), but only through (3) when returning, (1) being shut by the valve (2). During taxiing, a groove (4) acts as a supplementary orifice.



When we make a comparison, in Europe and the U.S.A., of the number of aircraft of a given type that must be manufactured in order to realise a financial gain, we quickly see that, at an equal sales price and insofar as such matters can be compared, the European aircraft industry manages to amortise its expenses with a smaller number of units than the U.S. industry does.

If we leave aside the question of wages—which for series of 100 units should represent a reasonable percentage—we are inclined to ask whether the high manufacturing costs in the U.S.A. are not due to the fact that, for the majority of problems, there exists this dispersion of effort, which is certainly beneficial owing to the multiplicity of aspects under which each question is approached, but one day might find itself out of proportion with the financial limits within which the problem must be kept.

It is probable that, in this matter as in many others, the truth lies between the two. This shows to what point it is valuable that engineers from both sides of the Atlantic should come together in order to find that correct middle way leading towards constructive solutions of the problems the future holds in store.

Evaluating the Traffic Potential of Continental and Intercontinental Airports

By Professor Dr. CARL PIRATH, Stuttgart

I. Goal and purpose of this study

The after-effects of World War II have made it very difficult for us to evaluate the future traffic potential of the European airports.

With regard to Germany, this question is of particular importance in view of the fact that, since 1948, non-German airline companies have been flying constantly increasing numbers of schedules to German centres, and because the airports have to be built, serviced and, if necessary, expanded by Germans. The present article is based on a scientific study I have made of the future traffic potentialities of German airports ; the methods employed, and the results obtained, can also prove useful with respect to the other European areas where civil aviation is practised.

It will be profitable to differentiate between those airports serving only continental air traffic and those situated on the intercontinental air routes.

II. The continental air traffic potential of German airports

With respect to the evaluation of the future air traffic potential of German airports in continental aviation, we have hardly any figures relative to other European airports, which could be used for making direct comparisons. We must therefore refer back to the conditions of domestic air traffic in the United States of America, where civil aviation was able to develop almost unhampered by the vicissitudes of war.

In the last years before World War II, when most of the air services were of a continental nature as regards range, almost equal technical and economic conditions could be ascribed to European and U.S. inland air transportation. If, therefore, it is possible to make a comparison of development between both regions for that time, with reference to the air traffic requirement, then use can be made of the subsequent development of U.S. civil aviation up to 1947 in order to evaluate the air traffic which may be anticipated in normal times

Area	Population (millions)		Outbound						Annual volume per 1,000 inhabitants					
			Passengers (× 1,000)		Freight (1,000 tns.)		Mail (1,000 tns.)		Passengers		Freight (kgs.)		Mail (kgs.)	
	1937	1947	1937	1947	1937	1947	1937	1947	1937	1947	1937	1947	1937	1947
I. Domestic and continental air traffic														
a) Germany	66	—	315	—	4.5	—	3.97	—	4.8	—	68	—	66	—
b) Europe (without Eastern countries)	233	—	1109	—	16.52	—	8.5	—	4.8	—	31	—	16	—
c) U.S.A.	131	133	1267	11100	4.04	104	9.3	85	9.7	83	31	780	72	640
II. Intercontinental air traffic														
a) Outbound North Atlantic traffic from Europe	—	356	—	110	—	3.5	—	2.6	—	0.3	—	10	—	7.3
b) Outbound intercontinental traffic from Europe	—	—	—	145	—	4.0	—	3.0	—	—	—	—	—	—

Table 1 : General specific traffic requirement in domestic and continental civil aviation of Germany, Europe, and the U.S.A., and also in intercontinental civil aviation, during 1937 and 1947

in Europe ; this we may do on the basis of what we shall call the specific traffic requirement, *i.e.*, the number of passengers and the amounts of freight and mail in tonnes (metric) per inhabitant and year.

In view of the similar economic structure, the specific traffic requirement of Europe, and notably Germany, bears a far-reaching likeness to that of the U.S.A. with respect to the most important transport medium of all, the railways.

This general similarity in traffic requirements exists with a limitation for civil aviation, however : the denser railroad network of 7.2 kms./100 sq.km. in Europe, and of 12.5 kms./100 sq.km. in Germany alone, against that of 5.2 kms./100 sq.km. in the U.S.A., has, together with the more intense travel schedules in European countries, offered much greater advantages to railroad transportation, with respect to frequency and travel time. In consequence, civil aviation in the U.S.A., as compared with transport by rail, has made for a greater advance as regards time and space than in Europe, and above all in Germany. The specific traffic requirement in civil aviation will therefore, generally speaking, be greater in the U.S.A. than in the European countries.

Table 1 presents the general specific traffic requirement in civil aviation for Germany, Europe and the U.S.A. during 1937, and that for the U.S.A. in 1947, for which year we have no reliable figures relative to Germany or Europe owing to the present situation.

The large freight transportation of Germany is explained by particular circumstances of the pre-war years, and is not to be regarded as normal. On the other hand, the ratio of 1 : 2 between Europe and the U.S.A. with respect to the general specific air traffic requirement for passengers, is typical and stems from the longer distances and the less dense railroad network in the U.S.A. Assuming that airline operating techniques were at the same level on both continents in 1937, the ratio can be regarded as normal and may be expected to remain valid in the future.

The general specific traffic requirement for Europe and for Germany would therefore, in the year 1947, amount to one half of the general specific traffic requirement of 83 passengers per 1,000 inhabitants given in Table 1 for the U.S.A.—thus 40 travellers per 1,000 inhabitants. In other words, the general specific traffic requirement of Europe, under normal economic conditions, will undergo an eight-fold increase from 4.8 to 40 travellers per 1,000 inhabitants. It seems safe to assume such an eight-fold increase over 1937 for freight and mail, too. If, for 1937, we introduce the mean figure between that value calculated in Table 1 for all Europe and that for Germany alone, then the general specific traffic requirement for 1947 amounts to :—

$\frac{31+66}{2} \times 8 = 50 \times 8 = 400$ kgs. freight per 1,000 inhabitants and year ;

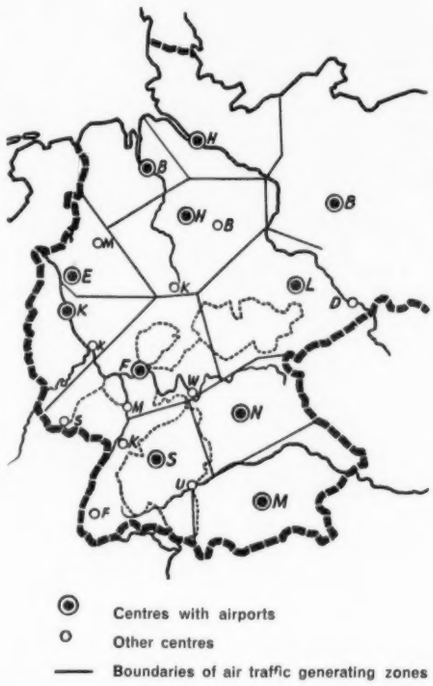
$\frac{16+66}{2} \times 8 = 41 \times 8 \leftarrow 330$ kgs. mail per 1,000 inhabitants and year.

From this we may calculate, in wide approximation, the figures for outbound passengers, freight and mail for the various airports.

The traffic generating zones served by German airports are presented here on a map, and their populations for the years 1939 and 1947 are given in Table 2. Because the 25 per cent. increase in population between 1939 and 1947 is due to displaced persons from Eastern European areas, thus people who will not acquire a standard of living compatible with civil aviation for some time to come, the population figures for the traffic generating zones, in order not to favour the calculation, have been set at only 10 per cent. higher than in 1939. Thus we find in Table 2 that the population of the traffic generating zone for Frankfurt is 7,284,000 (1939 figure plus 10 per cent.), so that the following annual figures may be calculated for Frankfurt :—

7,284 × 40 = 290,000 outbound passengers ;
7,284 × 400 kgs. = 2,900 tonnes outbound freight ;
7,284 × 330 kgs. = 2,400 tonnes outbound mail.

As regards the development of U.S. domestic civil aviation, a certain state of saturation has entered since 1947, which leaves only a moderate increase in inland air transportation to be anticipated. If, therefore, we increase by 25 per cent. the



Traffic generating zones of the Western German commercial airports

Table 2 : Traffic generating zones for the commercial airports of Western Germany in 1937 and 1947

Airport	Population of traffic generating zones (× 1,000)		
	1939	1947	
		1939 + 25 % (Including D.P.s. from Eastern European areas)	1939 + 25 % (Population liable to travel by air)
Bremen	1,582	1,977	1,740
Essen	5,675	7,094	6,242
Frankfurt	6,624	8,280	7,286
Hamburg	4,811	6,014	5,292
Hanover	4,222	5,277	4,644
Cologne	6,086	7,607	6,694
Munich	3,725	4,656	4,097
Nurnberg	2,607	3,259	2,867
Stuttgart	4,714	5,894	5,185
Total	40,046	50,058	44,047

civil aviation figures for 1947, then the development for the next five to ten years will have been sufficiently accounted for with respect to continental traffic. For the afore-mentioned example of Frankfurt, this yields an annual outbound air traffic potential of 362,000 passengers, 3,620 tonnes of freight, and 3,000 tonnes of mail.

In order to control the general specific traffic requirements, a further yardstick for evaluating the civil aviation requirement is useful. This is the special specific traffic requirement, which, instead of the generating zones, takes into account the most important generating centres of air traffic, namely the large cities equipped with airports, and places the number of outbound passengers and the amounts of outbound freight and mail in relation to the populations of these cities. This special specific traffic requirement is evaluated in Table 3.

Readers will not fail to notice the relatively high special specific traffic requirement for the U.S. capital, Washington, D.C., which is largely due to the fact that all the Government agencies, military and civil, are concentrated in that city. The comparatively high special specific traffic requirement of San Francisco originates primarily from the slow rail and sea communications between the main cities along the Pacific coast.

Under the assumption, also substantiated by Table 3, that the special and general specific traffic requirements in 1947 are eight times as great as in 1937, we find for Frankfurt, which, in 1938, had a specific traffic requirement of 50 passengers for 1,000 inhabitants and year :—

50 × 8 = 400 passengers,
700 × 8 = 5,600 kgs. of freight, and
1,445 × 8 = 11,560 kgs. of mail
per 1,000 inhabitants and year.

From the specific special traffic requirement of Frankfurt during 1947, and the city's population of 551,000, we obtain the following traffic figures for 1947 :—

551 × 400 = 220,000 outbound passengers ;
551 × 5,600 = 3,100 tonnes outbound freight ;
551 × 11,560 = 6,300 tonnes outbound mail.

If we again assume a 25 per cent. increase in traffic for the next five to ten years, we obtain 227,000 passengers, 3,870 tonnes of freight, and 7,880 tonnes of mail.

A comparison of the figures obtained for Frankfurt according to the two methods reveals a large difference in the amount of mail carried. This is explained by the central airmail position which Frankfurt occupied before the war, and which it is likely to assume again in the future. If we also take the higher values for passengers and freight obtained by the two methods, then we obtain, as end result, the following probable traffic potential for Frankfurt airport :—

362,000 outbound passengers ;
3,870 tonnes outbound freight ;
7,880 tonnes outbound mail.

III. The European airports' intercontinental traffic potentials

For the case that the continental airport has also to serve a certain area with intercontinental operations, then account must be taken of its intercontinental air traffic potential (see Table 1) in addition to the continental air traffic potential evaluated for it.

If we assume that there will first be ten intercontinental airports in Western Europe, the intercontinental traffic volumes radiating from Europe would usually be distributed in the ratio of 1 : 10. During 1947 there started from Europe

$$\frac{290{,}000}{2} = 145{,}000 \text{ passengers to other parts of the world.}$$

A tenth of these, namely 14,500 outbound passengers, could be ascribed to Frankfurt. There is no doubt that we can count on an increase of 100 per cent. in intercontinental aviation during the next few years, as, for example, the North Atlantic traffic in 1948, when 350,000 passengers were carried in both directions, was 59 per cent. higher than the 1947 figure of 220,000 passengers, so that Frankfurt can count on a future figure of 30,000 intercontinental air passengers.

This amounts to 8.3 per cent. of the city's highest figure in domestic and continental passenger traffic.

The total number of passengers departing from Frankfurt will consequently increase to 362,000 + 30,000 = 392,000 annually. Similarly, an increase of 8 to 10 per cent. can be applied to the figures for continental freight and mail traffic, so that Frankfurt airport can count on the following traffic quantities in continental and intercontinental civil aviation :—

Annually	*Daily with 300 traffic days a year*
392,000 passengers	1,300 passengers
4,260 tonnes freight	14.2 tonnes freight
8,670 tonnes mail	29 tonnes mail

IV. Conclusions

In this investigation the air traffic potential is based on the amounts of outbound passengers, freight and mail. In order to calculate the dimensions of the facilities for handling these three traffic branches, the figures must be doubled, thereby ascertaining the total potential of outbound and inbound traffic which would have to be dealt with. It has been seen from other investigations that we can usually assume for valuable and express traffic, which is the primary branch of civil aviation, that the number of passengers and the amounts of freight and mail for the airport are the same for outbound and inbound operations.

For taking into account the seasonal fluctuations of traffic requirement, the average daily traffic volume should be increased by 20 to 30 per cent. in order to be able to make the installations large enough to cope with peak traffic figures.

It is advisable to control the general and the special specific traffic requirements in continental and intercontinental aviation from time to time, in order to be able to evaluate anticipated developments in air transport requirement, and to obtain authoritative basic figures for planning the airport facilities and working the airport economically.

Table 3 : Special specific air traffic requirement of important cities with airports in Germany and the U.S.A. in 1938 and 1947

Airport	Population (× 1,000)	Outbound			Specific traffic requirement Outbound		
		Passengers (× 1,000)	Freight (1,000 kgs.)	Mail (1,000 kgs.)	Passengers	Freight (kgs.)	Mail (kgs.)
Germany in 1938							
Berlin	4,299	103	1,793	2,252	24	311	624
Bremen	341	4	31	4	12	91	12
Essen	671	7	59	37	10	90	56
Frankfurt	551	27	381	796	50	700	1,445
Hamburg	1,677	23	261	66	14	155	40
Hanover	462	7	332	1,215	10	720	2,695
Cologne	765	19	493	963	25	644	1,520
Munich	760	25	352	321	30	463	422
Nurnberg	413	5	57	132	12	138	320
Stuttgart	452	12	253	189	26	570	420
Totals and averages	10,391	232	4,012	5,975	23	401	597

U.S.A. in 1937 and 1947	Population (× 1,000)	Outbound passengers (× 1,000)		Specific traffic requirement Outbound passengers	
		1937	1947	1937	1947
New York	7,400	210	1,910	28	260
Chicago	3,400	187	1,280	52	377
Washington	663	126	1,010	190	1,500
San Francisco	634	72	533	113	840
Totals and averages	12,097	595	4,733	49	392

The Kellett XH-10 Heavy-Weight Helicopter

The helicopter types able to cope with more than one ton of payload can still be counted on the fingers of one hand. France has the 1,000-H.P. helicopter of SNCA du Sud-Est, the SE 3000 (developed from the Fa 223), which is now being tested in flight; Great Britain can boast the 1,635-H.P. three-rotor Cierva W. 11 "Air Horse"; and in the U.S.A. we find the 600-H.P. Piasecki HRP-1 "Rescuer" and the 900-H.P. McDonnell XHJH-1 types built for the Navy, and now the U.S. Air Force's 1,050-H.P. Kellett XH-10.

The last-mentioned of these, the XH-10 developed by Kellett Aircraft Corp. of North Wales, Pennsylvania, evinces particular interest in view of its twin-engined and twin-rotor configuration, and its method of compensating torque with counter-rotating, intermeshing rotors, a principle adopted from the original German Flettner helicopter. It is well able to fly on one engine, since a gearing located between the rotor shafts divides the engine power evenly between the two rotors and furthermore provides for the correct distances between the rotor blades.

The Kellett helicopter has been undergoing U.S. Air Force flight tests for about two years already, and is designed for transporting cargo and troops, and for rescue work. According to the manufacturers, the special features of the XH-10 are its extremely long range possibilities and high hovering ceiling.

In order to provide a clear picture of the XH-10's flight performance possibilities, Kellett Aircraft has calculated a number of operational examples. Though these are purely theoretical for the time being, they are nonetheless interesting, particularly as performance figures of such magnitude have hitherto never been attributed to any helicopter. It is shown that, if jettisonable auxiliary tanks are used (signifying a 50 per cent. overload), the XH-10, after a 190-ft. take-off run, can fly a 859-mile trip from its base to an eventual rescue point, hover whilst it uses its hydraulically-operated winch to haul up to six persons on board, and then return to base. A lapsed time of 20 hours is estimated for the entire operation; 1,120 U.S. Galls. of fuel are necessary, 16 per cent. being contained in the usual tanks and the remaining 84 per cent. in the jettisonable auxiliary tanks. It goes without saying that practical operations under such overload conditions would certainly take a heavy toll of engine and rotor life. However, it is unlikely that such great ranges will ever be necessary; the XH-10's normal range of 350 miles—and 640 miles in exceptional cases—both allowing for vertical take-offs, should suffice for the majority of air-sea rescue operations.

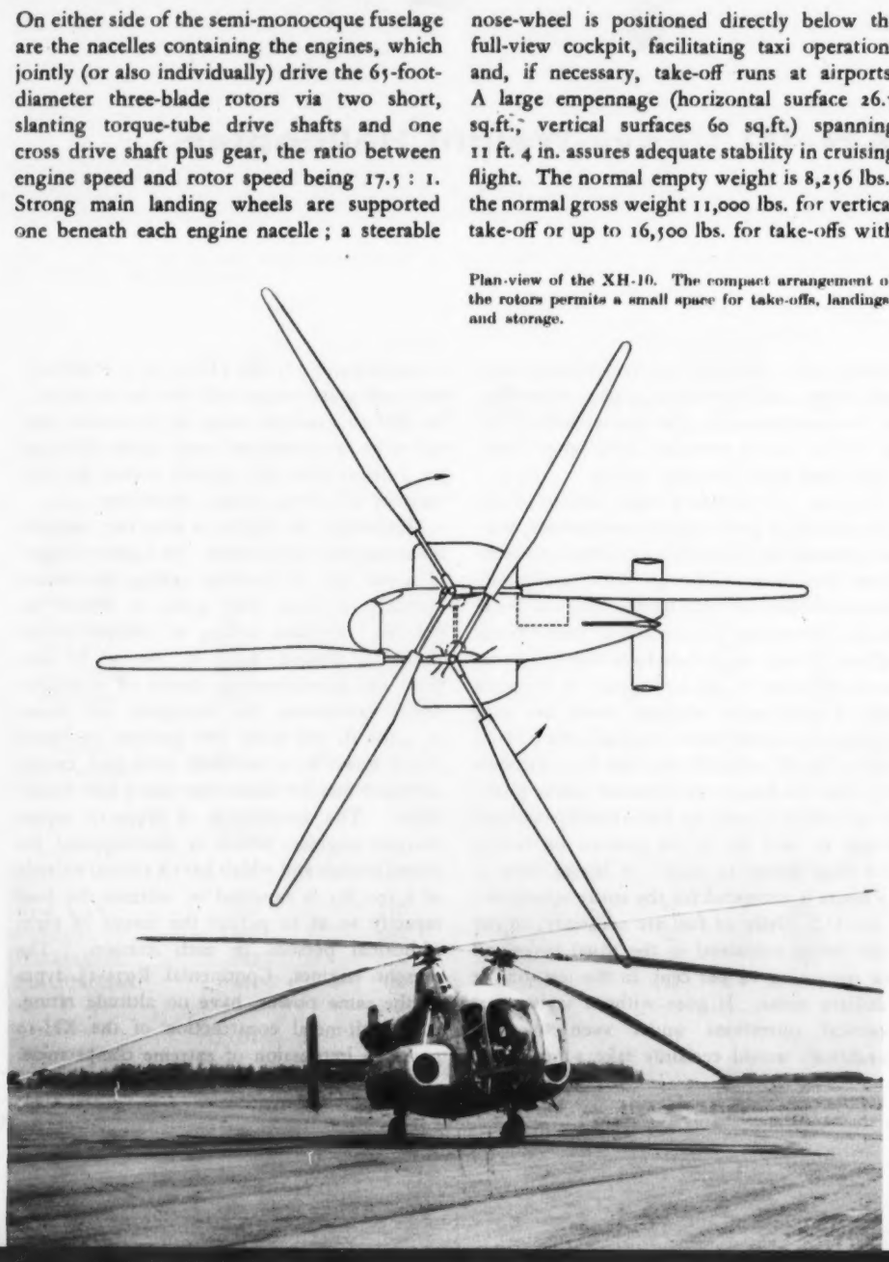
Meanwhile, the XH-10 is also very suitable for mountain rescue work. At a gross weight of 9,360 lbs., a hovering ceiling (in terrain vicinity) of more than 9,000 ft. should be possible; absolute ceiling in oblique ascent should be around 19,000 ft. As can be seen from the accompanying charts of mountain rescue operations, the helicopter can hover at 9,200 ft. and hoist two persons on board if it is flown by a two-man crew and carries sufficient fuel for about one and a half hours' flight. The installation of R975-17 supercharged engines, which is contemplated for future models and which have a critical altitude of 6,500 ft., is expected to increase the load capacity so as to permit the rescue of eight additional persons in each mission. The present engines, Continental R975-15 types of the same power, have no altitude rating.

The all-metal construction of the XH-10 gives an impression of extreme compactness.

Two 525-H.P. Continental R975-15 engines are mounted in nacelles outside the fuselage. Whilst taking up none of the cabin space, they involve no structural expense or frontal drag.

On either side of the semi-monocoque fuselage are the nacelles containing the engines, which jointly (or also individually) drive the 65-foot-diameter three-blade rotors via two short, slanting torque-tube drive shafts and one cross drive shaft plus gear, the ratio between engine speed and rotor speed being 17.5 : 1. Strong main landing wheels are supported one beneath each engine nacelle ; a steerable nose-wheel is positioned directly below the full-view cockpit, facilitating taxi operations and, if necessary, take-off runs at airports. A large empennage (horizontal surface 26.7 sq.ft., vertical surfaces 60 sq.ft.) spanning 11 ft. 4 in. assures adequate stability in cruising flight. The normal empty weight is 8,256 lbs., the normal gross weight 11,000 lbs. for vertical take-off or up to 16,500 lbs. for take-offs with ground run. In the latter event, as already stated above, a considerable shortening of rotor blade and engine life would have to be taken into account.

Plan-view of the XH-10. The compact arrangement of the rotors permits a small space for take-offs, landings, and storage.

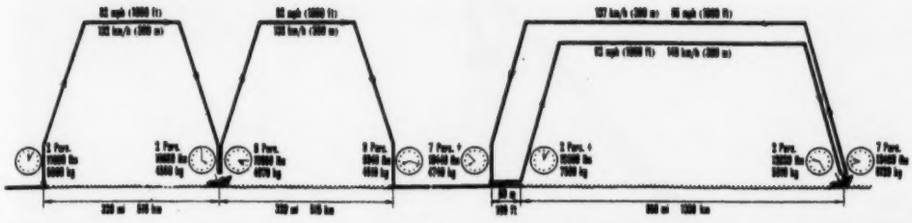


The engines, air-cooled nine-cylinder Continental R975-15 radials, have a rated output of 525 H.P. at 2,300 r.p.m. For taking off, however, they turn at 2,450 r.p.m., and should consequently step up the take-off power by about 6.5 per cent. In normal flight at 62 to 82 m.p.h., the engines turn at only 2,040 r.p.m., thereby making an adequate reserve of power available. Each engine crankshaft drives, via two clutches—a wet type multiple disc friction clutch and a jaw clutch—a stub shaft connected, through the oblique drive shaft and a spiral bevel gear set, with the rotors. The multiple disc friction clutch is used for bringing the rotors up to the engine speed. As soon as this is done, the jaw clutch is engaged, thereby assuring a positive drive connection between engine and rotor. The jaw clutches are designed to override, thus enabling one engine to drive both rotors and also making autorotation possible. When one engine drives both rotors, the helicopter remains capable of flight, even at full gross weight, at altitudes up to 4,600 ft.—although this naturally puts some strain on the operative engine. The clutches and gear sets are contained in their own magnesium housings located in front of the engines. The latter have no cooling fan, but are cooled by utilising an induced air flow through the nacelles, this being achieved by placing the exhaust pipes inside stainless steel venturi-shaped ducts ; further cooling is provided in flight by the drag wind. There is a built-in fire-extinguishing system.

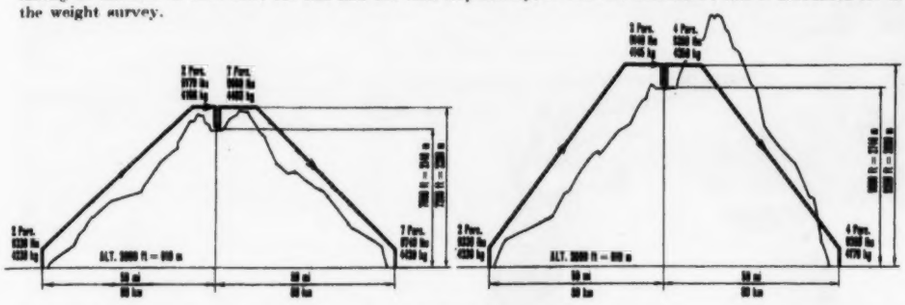
The torque-tube drive shafts connecting the engine and rotors—or rather the lower and upper transmission systems—have universal joints mounted on each end. Each of the upper transmissions consists of spiral bevel gears and planetary gears ; they are connected together by a hollow cross drive shaft, via universal joints, in such a manner that the blades mesh according to an exact timing system. This shaft also carries a multiple disc rotor brake for bringing the rotors to a quick stop upon landing.—As will be noticed, the mechanical layout for such a helicopter is fairly complex.

Each rotor measures 65 ft. across and therefore features a disc area of 3,320 sq.ft. In view of the intermesh, however, the wheel disc area measures only 3,710 sq.ft. The rotor shafts lie at an angle of 12.5 deg. to the vertical and the rotor heads are 6 ft. apart. The aerofoil section of the 1.5-foot-wide blades, turning at 117 to 140 r.p.m., is a modified NACA 23015. Each of the six blades consists of a wooden framework surrounding a chromium-molybdenum tubular steel spar, the latter

The two counter-turning, intermeshing rotors are synchronised. Their drive shafts build an angle of 25 degrees. On the starboard wall can be seen the folding door for access to the cabin, on the other wall the door entering the cockpit.



Example of an air-sea rescue mission, involving five to six persons. The 519-mile trip from base to rescue point takes 8¼ hours and requires a fuel supply of 340 U.S. Galls ; that along an 859-mile stretch lasts 19¾ hours and needs 1,120 U.S. Galls. as well as a 190-ft. take-off run. During the rescue operations over the wreckage point, lasting 15 minutes in each case, 120 lbs. and 180 lbs., respectively, of fuel are consumed ; this is accounted for in the weight survey.



Example of a mountain rescue mission. In about 1½ hours it is possible to effect a rescue of five persons stranded at 7,200 ft. or two persons at 9,200 ft., without the helicopter having to land at the rescue point. The base is assumed to be 50 miles from the rescue point, and situated at an altitude of 2,600 ft. above sea level. About 120 lbs. of fuel are consumed while hovering over the rescue point. The take-off is executed at a gross weight of 9,330 lbs., including 505 lbs. (85 U.S. Galls.) of fuel.

being step tapered ; the blades are carefully balanced, and attached to pivot (for flapping and rocking) at the rotor head.

The control is effected in the usual manner through a swashplate : on the one hand by cyclic pitch change with dual sticks (for longitudinal and lateral control), on the other by collective pitch control (ascent and descent) with a stick located between the pilots' seats. The collective pitch stick also carries two motorcycle-grip throttles, one for each engine. Dual pedals are used for the actual steering of the helicopter ; they differentially apply collective pitch to the rotors, thereby causing an incomplete compensation of the torque moments, and they also turn the rudder (attached to the middle vertical fin). The cyclic pitch stick and the rudder pedals act in the same manner as the controls of a conventional aircraft ; only the collective pitch stick is an additional means of control. Both sticks have spring bungee positioning devices, which help to "trim" the stick for various load conditions—for example, permitting full cyclic pitch stick control at large variations of C.G. movement, the cyclic pitch stick remaining in neutral position. All engine starting, clutch operation, and rotor brake operation are accomplished through an electrically-actuated system from the pilot's panel. Parking brakes, taxi brakes, full panel of flight instruments, complete radio installation and heating systems are also provided.

Aft of the cockpit is the cabin, measuring 112 inches in length and 70 inches in width, which can accommodate ten fully-equipped soldiers or six stretcher patients plus an attendant. Also, cargo can be carried : loads of 2,200 lbs. under normal take-off conditions, or up to 6,600 lbs. under overload conditions and with a take-off run.

A large, 4 ft. 7 in. wide, folding cargo door towards the rear end of the cabin, which opens up part of the floor and side wall, greatly facilitates loading operations. The cabin floor is approximately at the height of a truck platform, and in rescue missions, for example, persons can be loaded whilst the aircraft hovers, thanks to the hydraulic hoist that is installed on a swivel bracket directly over the doorway.

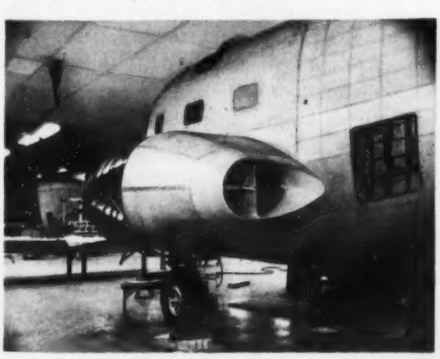
Dimensions, Weights, and Performance :

Fuselage length	28 ft. 8 in.
Fuselage width at engines .	14 ft. 7 ½ in.
Wheel tread	10 ft.
Height of rotor heads . . .	13 ft. 9 in.
Distance between rotor tips.	65 ft.
Distance between rotor heads	6 ft.
Total rotor disc area . . .	3,710 sq.ft.
Normal empty weight . . .	8,260 lbs.
Normal gross weight (vert. T. O.)	11,000 lbs.
Gross weight with max. overload (T. O. run)	16,500 lbs.
Normal tankage (180 U.S. Galls.)	1,080 lbs.
Rated power at 2,300 r.p.m..	1,050 H.P.
Rotor disc loading	2,97 lb./sq.ft.
Power loading at 2,300 r.p.m.	10,5 lb./H.P.
Maximum speed at sea level.	121 m.p.h.
Maximum speed at 13,000 ft.	90 m.p.h.
Cruising speed at 1,000 ft.	62-82 m.p.h.
Hovering ceiling at 11,000 lbs.	6,000 ft.
Hovering ceiling at 9,360 lbs.	9,200 ft.
Service ceiling in forward flight at 11,000 lbs. . . .	18,000 ft. (in 29 min.)
Rate of climb at sea level (11,000 lbs., 2,450 r.p.m.) .	1,650 ft./min.
Range with normal tankage.	350 miles
Range with extra tanks . .	1,720 miles

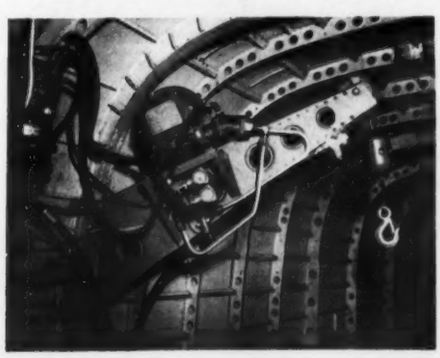
Two years of flight tests with the XH-10 seem to have led to satisfactory results : a maximum speed of 121 m.p.h. has been attained and the machine has climbed to 12,000 ft. in oblique ascent. In vertical ascent the XH-10 has so far reached 4,000 ft., hovered in still air at a gross weight of 15,500 lbs., and climbed at 300 ft./min. (sea level) on one engine. Taxi tests at speeds up to 70 m.p.h. were executed to demonstrate its ability for aeroplane-type take-offs. In winds up to 45 and 65 m.p.h. and in driving rain, the XH-10 accomplished trips over mountainous terrains under low-ceiling and storm conditions which caused other aircraft to be grounded. Both glides and landings can be effected in autorotation, *i. e.*, with the engines cut out, at a low rate of descent and without the controllability suffering in any way.

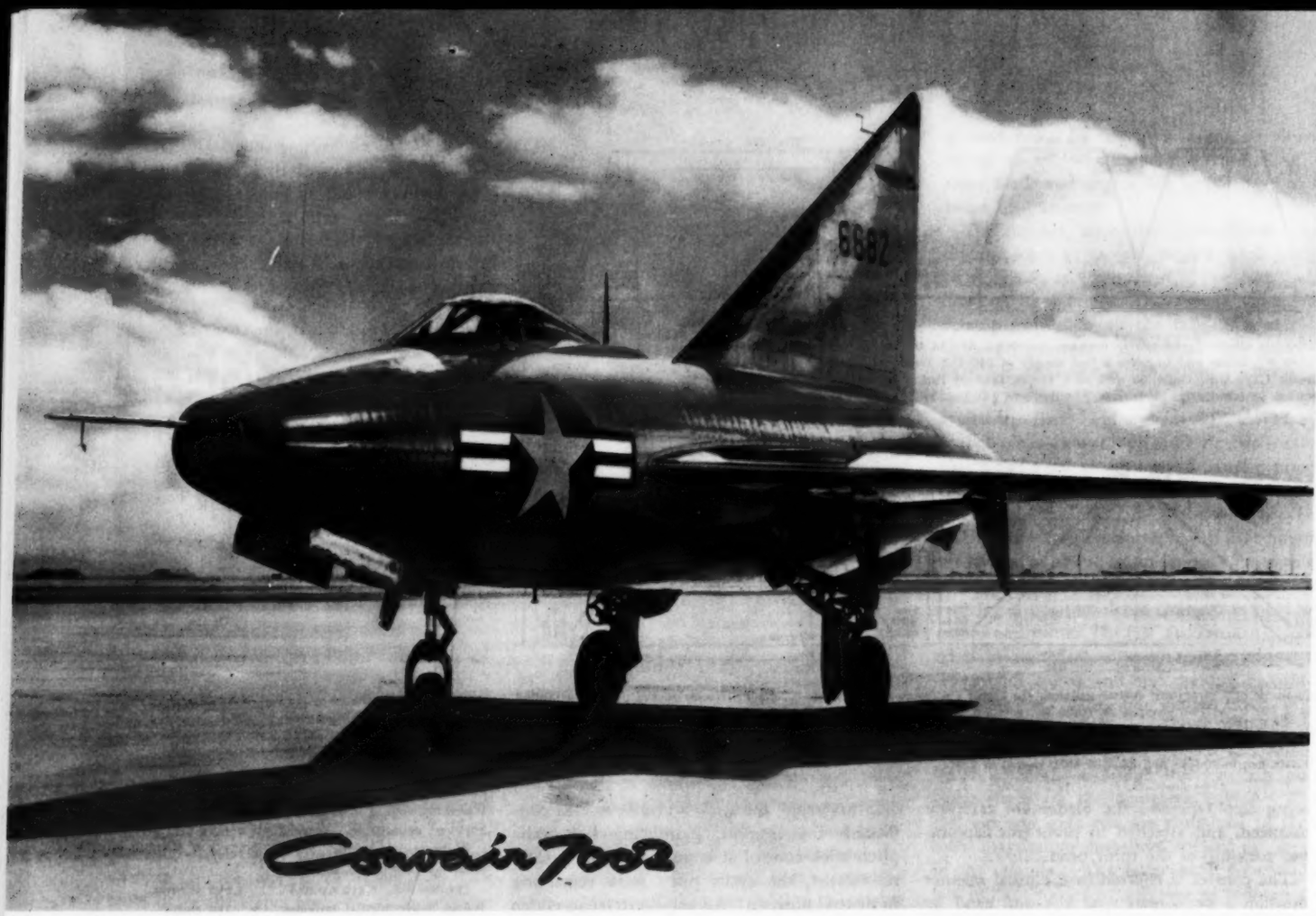
In conclusion, it should be mentioned that Kellett Aircraft Corp. is planning a civil version of the XH-10. This should provide a comfortable cabin with ten passenger chairs facing forwards, and a convenient entrance door in place of the folding cargo doorway. Realisation thereof nevertheless depends on whether operators display sufficient interest in the idea ; the structural modifications and the C.A.A. certification procedures represent fairly high expenses. The civil version would be known as the KH-2 and be used for city-to-airport services, sight-seeing flights and the like.

For cooling the engines, the exhaust stacks are placed in stainless steel venturi-shaped ducts, giving rise to an induced air flow which enables cooling fans to be eliminated and power to be saved.



A hydraulic hoist capable of lifting 250 lbs. is mounted on a swivel bracket directly above the loading door. In addition to cargo, it can also be used for lifting stretcher patients, etc., during rescue operations.





The tricycle undercarriage, of moderate tread, retracts completely into the wing and fuselage nose. The turbo-jet's air intake is visible in the nose

"What's new about delta wings anyhow ? I remember the days when we used the principle to annoy our schoolteachers—and that was long before the Wright brothers flew ! Our constructions were fast, too . . . and stable ; very good for liaison work."

Our white-haired narrator is sunk in reverie—thinking back on his boyhood . . . and maybe, also, on the man who said there is nothing new under the sun ! But he is willing to admit, all the same, that there is a respectable difference in wing loading between the paper dart of his schooldays and America's latest high-speed research aircraft, the Convair 7002.

Consolidated Vultee Aircraft Corp. states the gross weight of the Convair 7002 to be 13,000 lbs. The wing is in the shape of an equilateral triangle, of thin aerofoil section, measuring 31 feet in span ; thus its area, not counting the 3 1/4-foot-wide fuselage, is 285 sq.ft. Its wing loading, which works out at 46 lbs/sq.ft., is therefore easily a thousand times greater than that of the paper dart of our schooldays.

Granted, a wing loading of 46 lbs /sq.ft. is no longer a record for modern high-speed aircraft, but just a good average value. Present-day fighters take off with wing loadings of between 40 and 60 lbs./sq.ft. ; certain advanced aircraft, such as the Boeing "Stratocruiser," for instance, do the trick at 80 lbs./sq.ft. However, one should not fail to note the extremely low aspect ratio of the delta wing. Geometrically speaking, it amounts to 2.3, but in reality—because of the sharp drop in spanwise distribution of lift—it is considerably lower.

In flight, this means that the effective angle of attack, in view of the strong downwash, is considerably reduced, so that the aircraft probably begins to receive its maximum lift at angles of attack between 30 and 40 degrees. No undercarriage and no stunt flyer in the world can hope to cope with this. There is consequently no alternative to small angles of attack and extremely high take-off and landing speeds. The L/D values are very low, meaning it is probable that delta-wing aircraft can make landings at large angles of attack only with the aid of considerable engine power. In any case, it is likely, even at the high take-off angle of attack discernible in the accompanying photos, that the Convair 7002 has a take-off speed of around 220 m.p.h. and a landing speed of about 200 m.p.h.—Fifteen years ago these were *maximum* speeds for single-seat fighters !

The Convair 7002, meanwhile, is designed for high subsonic speeds. It is powered with an Allison J-33 turbo-jet which, with water injection into the combustion chambers, furnishes a maximum static thrust of 5,200 lbs. at sea level, though this can be stepped up for brief periods if an afterburner is adopted. Assuming flying speeds around the 600 m.p.h. mark and considering a fair drop in thrust during flight, the effective propulsive output of the turbine would therefore amount to only about 7,500 H.P.—and the aircraft's wing power to approximately 26 H.P./sq.ft. These values would not be sufficient for reaching the sonic limit in low altitudes. On the other hand, the aircraft could possibly attain nearly sonic speeds in horizontal flight at over 40,000 feet (where the speed of sound is only about 660 m.p.h.), especially with an afterburner ; and it is safe to assume that it could pierce the sonic barrier in a dive.

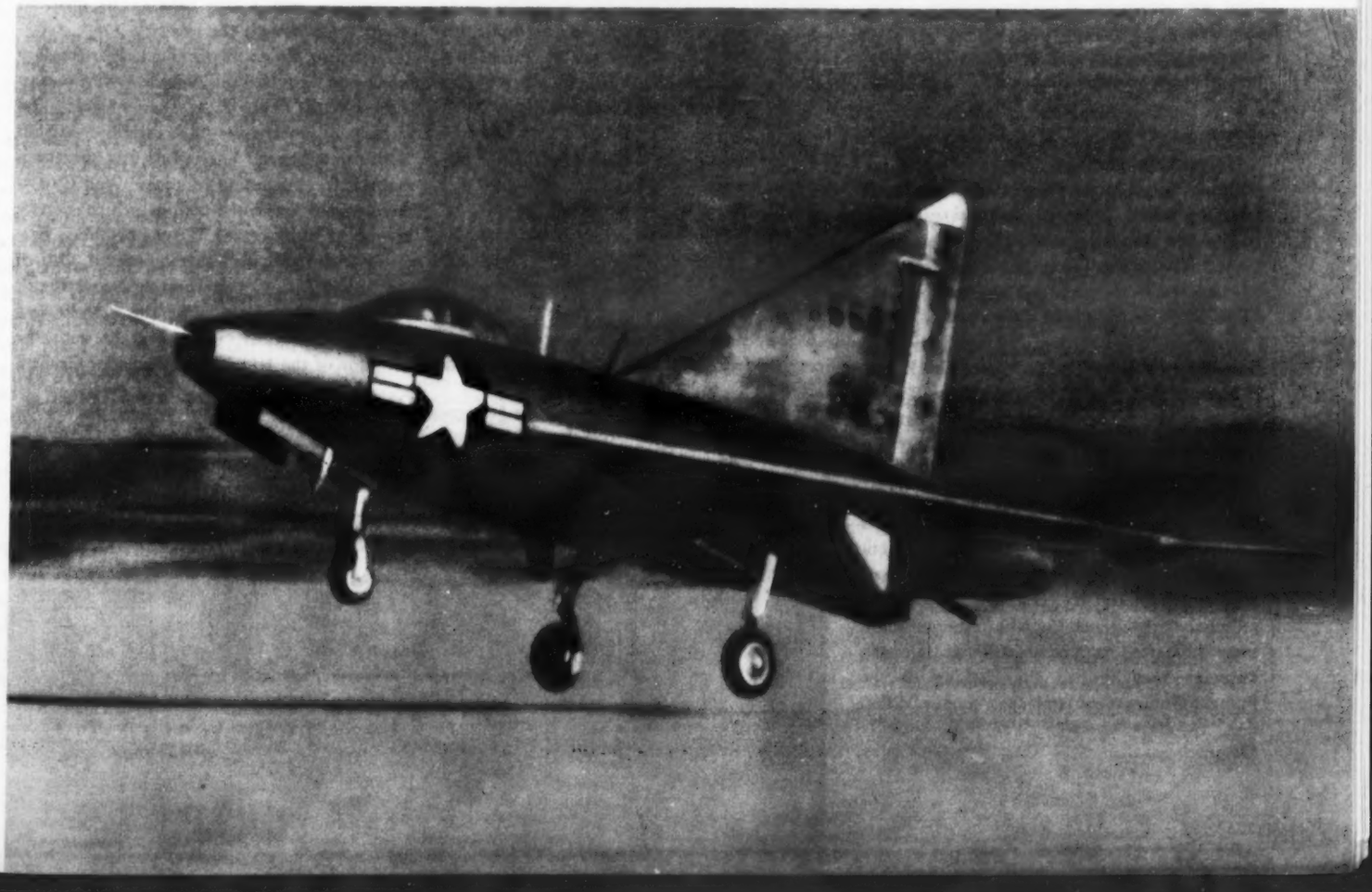
Meanwhile, the Convair 7002 was not developed for establishing new speed records, but

Convair 7002 research aircraft over California's Mojave Desert. The wing incorporates trailing-edge elevons for aileron and elevator action. The huge fin carries a rudder

for studying the suitability of the delta-wing configuration, its stability and control characteristics in the subsonic domain. After extensive wind-tunnel research, a Convair group headed by Project Engineer T. M. Hemphill began on what was originally intended to be a flying mock-up for testing the delta-wing configuration as a phase in the development of the Convair XF-92 supersonic fighter; though the latter aircraft has been dropped, work is continuing on the 7002 as part of Convair's research programme. The new experimental aircraft has already made its first flights, over the eleven-mile-long and four-mile-wide hard, duckered-mud surface of Muroc Dry Lake, the U.S. Air Force's big test base in California. Out of this veritable fortress against prying eyes and information leaks, it is understandable that only such details as are expressly released by the USAF will reach the public. These details are scanty enough, but though they give no performance figure, they do include a few photos, a few dimensions, and finally the laconic report : "Research is being continued."

Supersonic wind-tunnel research is also continuing. In the 34th Annual Report of the U.S. National Advisory Committee for Aeronautics (NACA), covering the fiscal year 1948, there is mention of studies to determine the stability and control characteristics, at subsonic and supersonic speeds, of triangular wings having a thin, double-wedge section and leading-edge sweepbacks of 53, 63, 76 and 83 degrees . . . which brings us right back — admittedly at a different level—to the paper darts of years ago.

How would you like to try taking off and landing at 200 m.p.h. ? This is all in the day's work for the pilots of Convair's San Diego Division Flight Department.



CURTISS-WRIGHT
after Two World Wars

It is not always possible to avoid noise in the aircraft and aero-engine construction field. And the noise occasionally drifts even into the management quarters. In the case of Curtiss-Wright Corporation, one of America's foremost aeronautical manufacturing concerns, an opposition group of stockholders made a lot of noise around the middle of 1948 . . . grumbling that the management was too quiet.

Under the leadership of a New York lawyer named T. Roland Berner, a three-man committee of common stockholders was formed, which attempted to stall the company's annual meeting and elect eight new directors of its own choice in order to take control of Curtiss-Wright.

The opposition committee was not voicing its protests against C.W.'s financial situation. On the contrary, it claimed that the company had an excessive surplus of cash on hand, on which inadequate common dividends were being paid out, and further alleged that the resulting "sluggishness of the present management" was partly responsible for a "steady loss of competitive position by the company."

Clearly, the root of the matter was that the stockholders wished to know more about what was going on at Curtiss-Wright. And this was a painful posture of affairs for a company where so many persons are at work behind doors marked "Restricted—Keep Out."

Traditional reticence

Historically speaking, Curtiss-Wright Corporation has a perfect right to name itself after America's great aeronautical pioneers. It is not as though the Wright brothers and Glenn H. Curtiss were the direct founders of the present concern—but they will always be regarded as the grand old chiefs.

Meanwhile, the gradual fusion of the early foundations is not difficult to trace back, and it is quite right that this year Curtiss-Wright should celebrate the twentieth anniversary of the Curtiss-Wright Corporation, the thirtieth of its Wright Aeronautical Corporation and the fortieth of the Curtiss airplane companies.

It is well known that the Wright brothers made themselves conspicuous by their reticence. In 1904, when the news of their first successful hops at Kitty Hawk reached Europe, a French Army officer, Captain Ferber, straight away took steps to purchase a Wright aircraft, knowing that he had the backing of the French Government and that money didn't

"Do you realise what picture you are taking? This is the king of the air and the king of the roads." These words by Henry Ford were recorded by the photographer who snapped the motor-car pioneer and Glenn H. Curtiss (left) with one of the first Curtiss flying boats.

count. The Wrights gave him a prompt, polite but negative reply: they hadn't got that far. After forty-nine successful flights, including a trip of twenty-five miles in thirty-eight minutes on October 5th, 1905, they suddenly cloaked themselves in impenetrable silence, sharply repulsed any attempt by the press to approach them, and seemed perfectly content to have people call them bluffers. Even when he went to Europe in 1907, distrustful Orville Wright carried neither plans nor diagrams, with the result that, upon his return to the U.S.A., he was to learn how malicious tongues had turned the "Flying Brothers" into "Lying Brothers."

Glenn Hammond Curtiss, too, was very silent for several months, though for a rather different reason.

Of Curtiss, it would be more exact to say, not that he discovered aviation, but that "he was discovered for aviation." And his reticence was closely coupled with this discovery.

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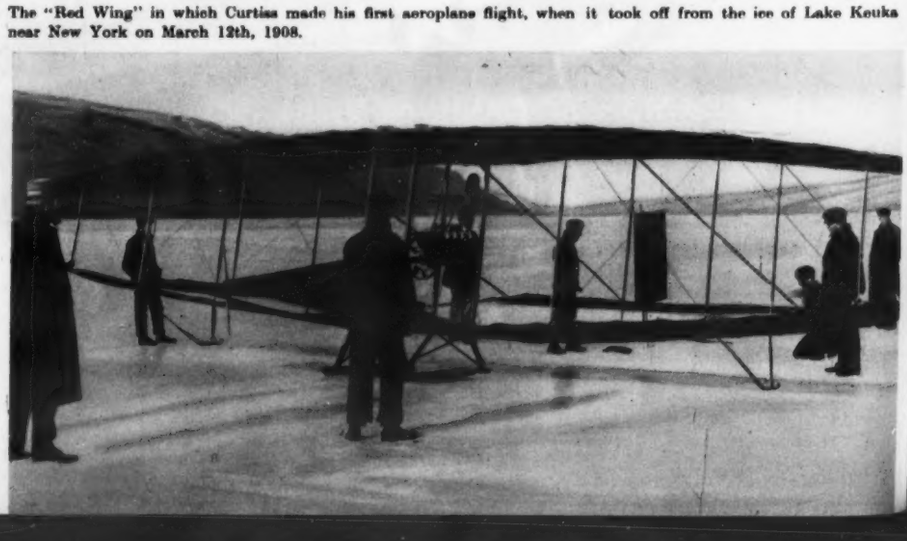

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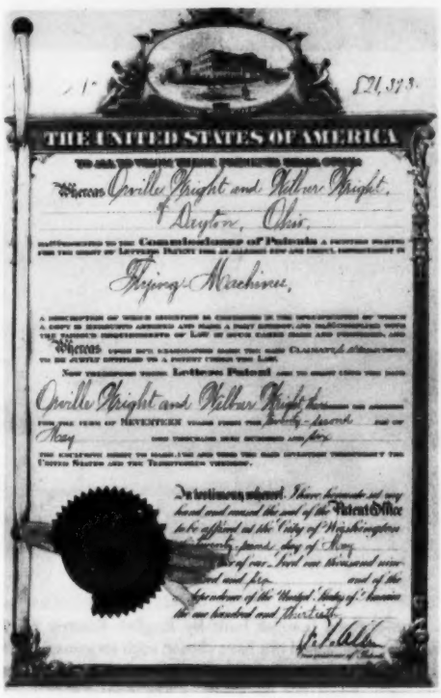
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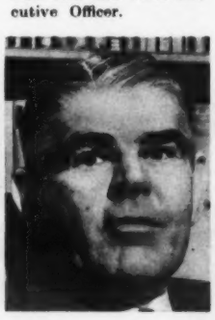


CURTISS-WRIGHT
after Two World Wars

It is not always possible to avoid noise in the aircraft and aero-engine construction field. And the noise occasionally drifts even into the management quarters. In the case of Curtiss-Wright Corporation, one of America's foremost aeronautical manufacturing concerns, an opposition group of stockholders made a lot of noise around the middle of 1948 . . . grumbling that the management was too quiet.

Under the leadership of a New York lawyer named T. Roland Berner, a three-man committee of common stockholders was formed, which attempted to stall the company's annual meeting and elect eight new directors of its own choice in order to take control of Curtiss-Wright.

The opposition committee was not voicing its protests against C.W.'s financial situation. On the contrary, it claimed that the company had an excessive surplus of cash on hand, on which inadequate common dividends were being paid out, and further alleged that the resulting "sluggishness of the present management" was partly responsible for a "steady loss of competitive position by the company."

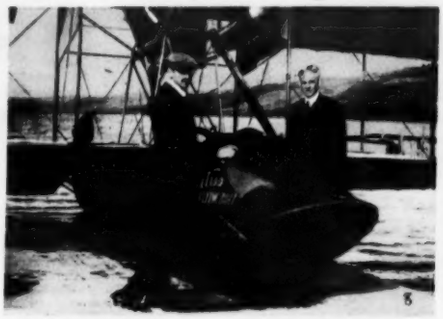
Clearly, the root of the matter was that the stockholders wished to know more about what was going on at Curtiss-Wright. And this was a painful posture of affairs for a company where so many persons are at work behind doors marked "Restricted—Keep Out."

Traditional reticence

Historically speaking, Curtiss-Wright Corporation has a perfect right to name itself after America's great aeronautical pioneers. It is not as though the Wright brothers and Glenn H. Curtiss were the direct founders of the present concern—but they will always be regarded as the grand old chiefs.

Meanwhile, the gradual fusion of the early foundations is not difficult to trace back, and it is quite right that this year Curtiss-Wright should celebrate the twentieth anniversary of the Curtiss-Wright Corporation, the thirtieth of its Wright Aeronautical Corporation and the fortieth of the Curtiss airplane companies.

It is well known that the Wright brothers made themselves conspicuous by their reticence. In 1904, when the news of their first successful hops at Kitty Hawk reached Europe, a French Army officer, Captain Ferber, straight away took steps to purchase a Wright aircraft, knowing that he had the backing of the French Government and that money didn't



"Do you realise what picture you are taking? This is the king of the air and the king of the roads." These words by Henry Ford were recorded by the photographer who snapped the motor-car pioneer and Glenn H. Curtiss (left) with one of the first Curtiss flying boats.

count. The Wrights gave him a prompt, polite but negative reply: they hadn't got that far. After forty-nine successful flights, including a trip of twenty-five miles in thirty-eight minutes on October 5th, 1905, they suddenly cloaked themselves in impenetrable silence, sharply repulsed any attempt by the press to approach them, and seemed perfectly content to have people call them bluffers. Even when he went to Europe in 1907, distrustful Orville Wright carried neither plans nor diagrams, with the result that, upon his return to the U.S.A., he was to learn how malicious tongues had turned the "Flying Brothers" into "Lying Brothers."

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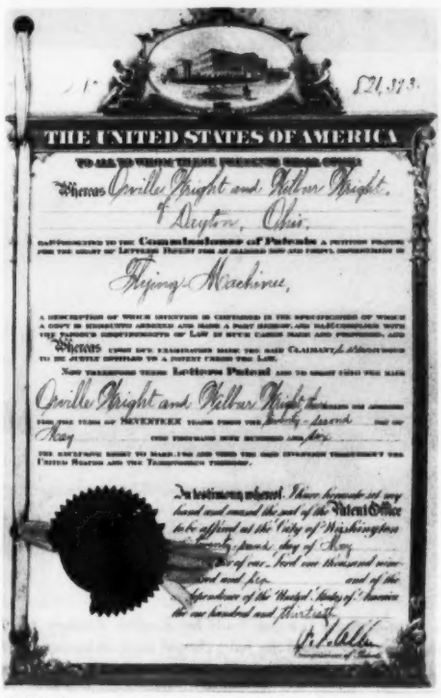
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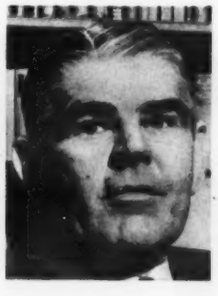

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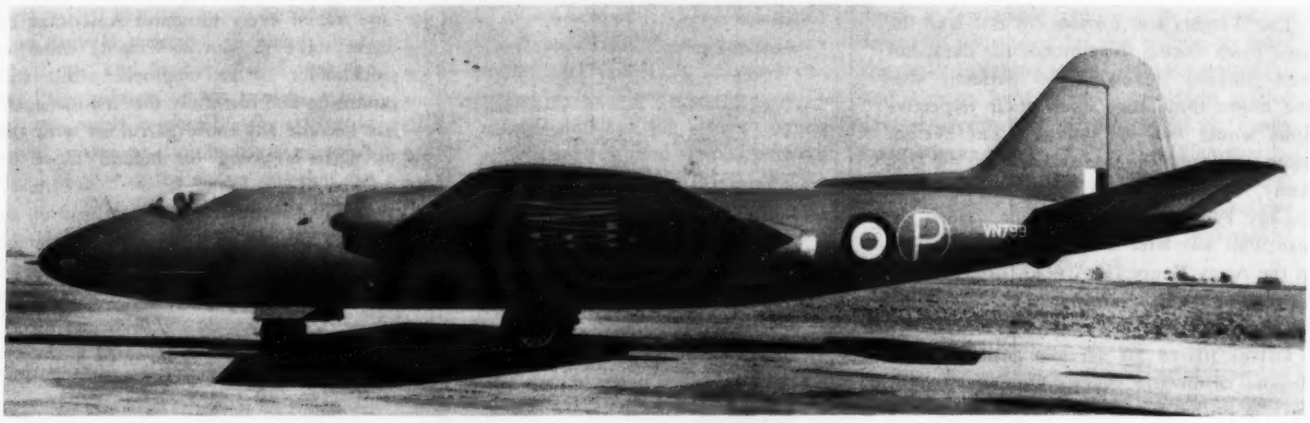
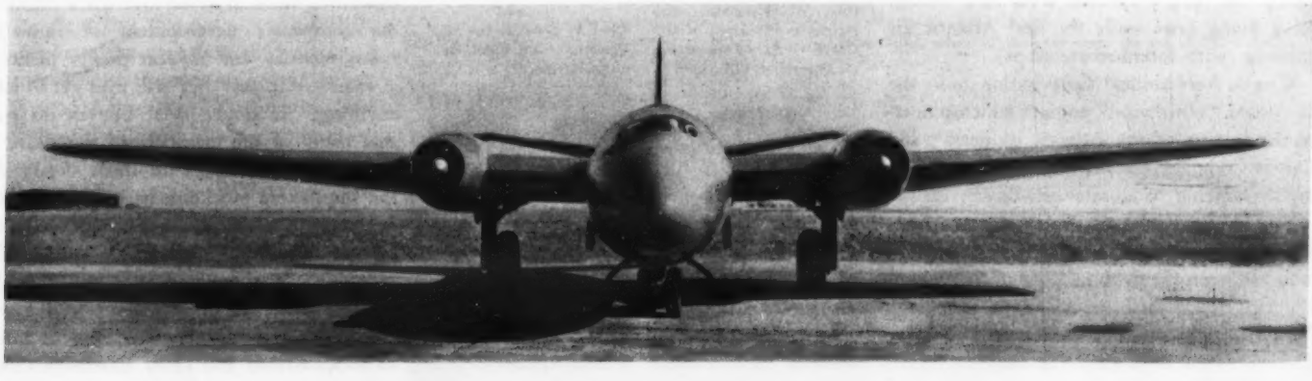
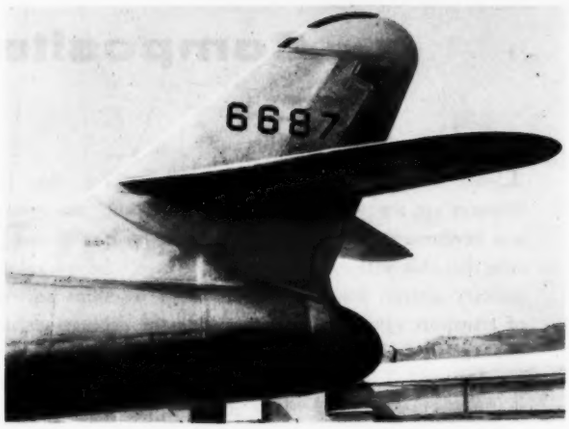
Progress

LONDON TO PARIS IN 21 MINUTES! Britain's latest single-seat jet aircraft, the HAWKER P. 1052 was not so well known until its record flight on the occasion of the 1949 Paris Air Show. The Hawker P. 1040 and N. 7/46 experimental aircraft preceded it and set the pattern for the fuselage and engine installation. The new aspect is provided by the swept-back wing, with which Hawker Aircraft Ltd. follow the example of several recent designs—for example, the de Havilland D.H. 108 research type—and which should endow the aircraft with a speed around 700 m.p.h. The P. 1052 is powered by a Rolls-Royce "Nene" turbo-jet and has two air inlets in the wing roots and two jet outlets on either side of the fuselage. At present a research aircraft, its basic design is expected to give birth to new fighters for Britain's air arm.

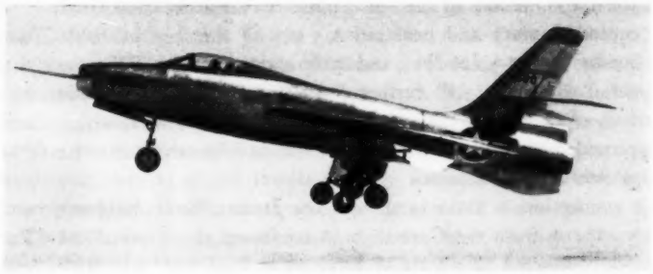


FRIDAY, 13th MAY, 1949: first flight of the British A.1 twin-engined bomber built by English Electric Co.! Apparently, aircraft manufacturers are not superstitious, or otherwise they would not have chosen such an inauspicious date for the aerial baptism of Britain's first jet bomber (and the first new bomber since the Avro "Lincoln"). Data on the A.1 are still hush-hush, but a safe guess is that it will reach speeds not far short of the 600 m.p.h. mark and possess an impressive range of action.

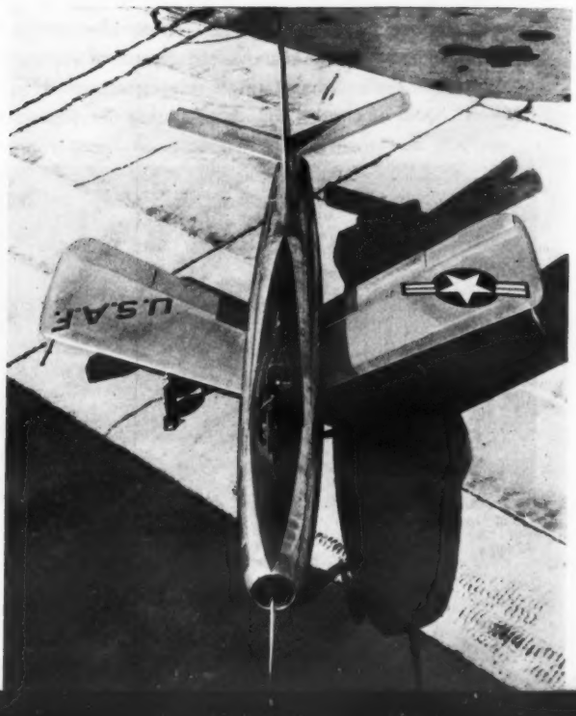




A BULLET-SHAPED, SLENDER FUSELAGE NOSE for the U.S. Air Force's new twin-engined long-range interceptor fighter, the Lockheed XF-90, is the "gen" for aircraft-recognition fans. The first photos were released only recently, and Lockheed Test Pilot Tony LeVier will in all likelihood be testing the XF-90 by the time these lines are printed. Two Westinghouse J-34 turbo-jets are housed alongside each other in the fuselage centre portion, and a relatively small, high-set empennage, sharply swept-back, is positioned above the two jet outlets. Extra power is furnished by two rocket booster units. Grossing approximately 24,000 lbs., the XF-90 is expected to break through the sonic barrier.



HORIZONTAL SPEEDS APPROACHING 900 M. P. H. at high altitude are anticipated of the prototype of the Republic XF-91 single-seat fighter! The fuselage nose containing a central air intake for the General Electric J-47 turbo-jet offers nothing out of the ordinary—but the rear fuselage looks highly unusual. Rocket motors positioned above and below the jet orifice are expected to shoot the XF-91 through the sonic wall. The extremely thin wing is—like so many of the latest high-speed designs—sharply swept-back, but its inverse taper is an uncommon feature. A particularly novel aspect is provided by the landing gear, whose designers seem to have trodden entirely new paths. In order to be able to retract the main wheels into the wing—the mid-wing design offers no alternative—two pairs of tandem wheel-sets had to be provided. This was the only way of distributing the load over the very narrow, high-pressure tyres. The shock struts are supported approximately halfway along each outer wing and the wheel pairs fold *outwards* and upwards into the wing. Compared with the length of 45 feet, the XF-91's span of only 30 feet seems exceptionally small.



Composite Aircraft for Combat

Even though the old principle of warfare, that intercontinental disputes are always settled by the side having the greatest sea power, was confirmed anew in World War II, no one would like to say for sure that this will continue to be the case. Schnorkel submarines and military aircraft are dangerous foes of warships and deadly enemies of transport vessels. Leaving aside the submarines, we find on the attacker's side long-range and dive bombers, equipped with explosive bombs, guided bombs, robot bombs and, last of all, atomic bombs ; the defenders have at their disposal concentrated A.A. armament, missiles equipped with proximity fuses, guided missiles, fighter aircraft and aircraft carriers.

The efforts which a land power can make to hinder an opposing sea power's operations, notably landings, are still today of the highest significance.

In this connection it is worth our while to take notice of the some 200 "Mistel" (mistletoe) composite aircraft which the Germans had in readiness towards the end of the war, for attacking ships—and also power stations, dams and other important compact targets—and which could have become a deadly weapon if... the Allies had not kept their eyes open. Before the "Mistel" made its first appearance, in July of 1944 around Caen, the Allies had terminated their decisive landings in North Africa, Sicily and Normandy. Instead of the Allied battleships and convoys, and the major Russian power stations, the "Mistel" was used against railway and road bridges in the Rhein and Oder areas...

The idea of developing the "Mistel" came, on the one hand, from the manned winged rocket bombs of the Japanese Kamikaze units, which achieved a certain amount of success, though at the loss of the pilots, against U.S. vessels in the Pacific, and on the other hand from the inadequate accuracy and penetration force of the then available vertical bombs (up to 3,100 lbs.) and radio-guided bombs (FX-1400 and Henschel HS 298), still further limited by the low payloads characteristic of German bombers. Meanwhile, dive bombers, which at least provided greater accuracy, were too easy a target for the battleships' anti-aircraft defences.

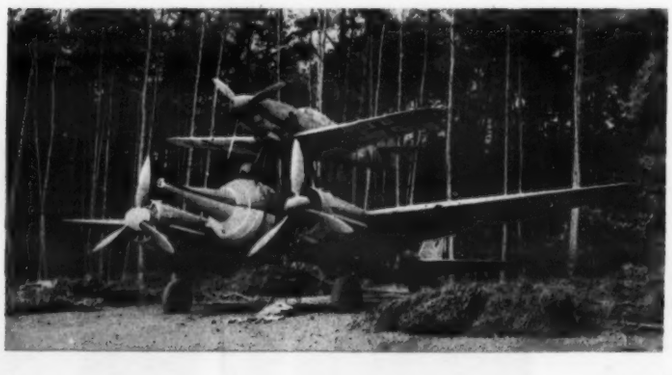
In this connection it looks as though the *Junkers-Werke* designers and a few experts from the German high command remembered the experiments conducted by Shorts in England in 1936 and 1937 with the Mayo composite aircraft, consisting of a large flying boat carrying a small seaplane on its back. The German idea was to transform the lower component into an unmanned carrier of explosives and to use as upper component a fast single-seat fighter from which the entire "Mistel" could be controlled. After aiming the destructive component at the target—in steep or dive flight—the fighter had to release itself and return to base as best it could.

The first of the "Mistel" tribe were built up from converted Junkers Ju 88 A-4 dive bombers (with two liquid-cooled Jumo 211 J engines each giving 1,400 H.P. take-off power) and Me 109 G single-seat fighters (with liquid-cooled Daimler-Benz DB 605 A engines of 1,500 H.P. take-off power). In later versions, Focke-Wulf Fw 109A fighters were combined with Ju 88 G and H bombers, whose 1,750-H.P. air-cooled BMW 801 D engines (which also powered the fighter) gave a greater range ; and since both components had the same types of power plant, the pilot was relieved of regulating the cooling of the unmanned aircraft's engines.

The Ju 88's front portion was modified to carry a 7,700-lb. warload, consisting of an extremely effective hollow charge with a protruding firing tube, and two approximately six-foot-high faired struts were mounted dorsally to support the fighter. The latter was attached to the struts by joints which could be snapped by a small, electrically-actuated explosion. Two principal attachments carried the main load, and a third, aft-positioned, auxiliary attachment served to set the fighter's angle of incidence relative to the bomber and was joined to the left support by an articulated strut. When the lock on the articulated strut was released by operating a lever in the fighter's cockpit, it folded backwards, gave the fighter a larger relative angle of incidence, and, upon reaching its end position, tripped a switch which fired the explosive joints and separated the two components. This method of separation was safe and rapid. According to the speed the combination had, the initial acceleration of the fighter varied between 3 and 7 *g*.

The controls and instruments for the Ju 88's engines, propellers, undercarriage and flaps were installed in the fighter's cockpit. The throttle valves were actuated directly by means of rods, but an electro-hydraulic servo system was evolved for propeller-pitch, undercarriage and wing flap operation. A control system specially built for the "Mistel," which used small electric motors to move the Ju 88's control surfaces, enabled the entire contraption to be controlled with the stick and pedals of the fighter aircraft. The pilot was assisted by a Patin automatic pilot, though this was primarily for exact aiming and may also have facilitated the difficult take-off procedure.

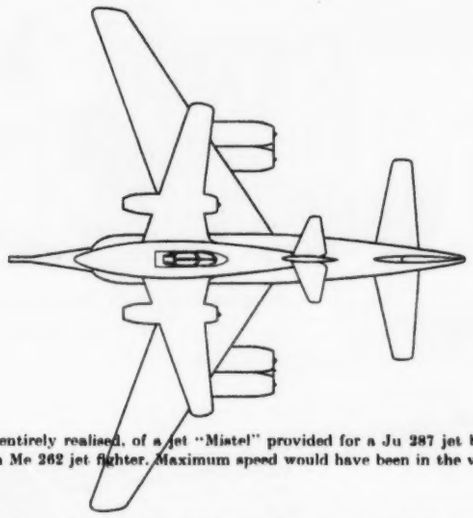
During the outbound flight towards the target, the fuel for the upper component was taken from the bomber's tanks. In this way the fighter could start off on its return trip with its own tanks full. Auxiliary tanks in the Ju 88's fuselage and jettisonable tanks beneath its wings stepped up the range to 2,400 miles. In such a case, of



The "Mistel" ready for combat consisted of a converted Ju 88 bomber, with the warload in its forward section, and an Me 109 or Fw 190 single-seat fighter mounted on its back. The ten-foot-long tube protruding from the bomber's nose contains four independent fuses.

The warload, a hollow charge of about 3.5 tons, was attached to the Ju 88's centre fuselage by four ball-and-socket joints.

In the trainer version of the "Mistel," both the upper and lower components were manned.



A project, never entirely realised, of a jet "Mistel" provided for a Ju 287 jet bomber combined with an Me 262 jet fighter. Maximum speed would have been in the vicinity of 500 m.p.h.

course, the fighter could not fly all the way back to the point of departure, but had to make for an alternative base. The average speed of the loaded "Mistel," which, as a biplane, naturally furnished an appreciable amount of drag, was 210 m.p.h. at 13,000 feet.

At a distance of six to ten miles from the target, the pilot—weather permitting—initiated his attack from an altitude of 10,000 to 16,000 feet. Otherwise the lowest cloud level dictated the departure altitude, and the approach distance had to be shortened accordingly. At incline angles of 20 to 25 degrees and speeds around 350 m.p.h., the target was approached on full engine power, at first manually and lastly with the autopilot. After final course corrections with respect to side-winds, and once the angle of inclination was set right—there was a special aiming device for both these purposes—the fighter was released at a distance of about two miles from the target. The bomber continued in a power glide on its set course, carrying its destructive load towards the target.

Operational reports on this novel and deadly weapon are likely to be short and few, and are probably locked up in the safes of the General Staffs of the victor nations. It appears that only one attempt was made to attack a large battleship, and it had to be abandoned because of the latter's thick smoke-screen. However, it is possible that a few transport vessels may have fallen victim to the "Mistel." Planned attacks with large numbers never came about because the Germans found themselves in hurried retreat before the "Mistel" was available in sufficient number.

One shortcoming of the composite design was that the Ju 88's undercarriage was too weak. This defect was notorious: even in normal operation without a fighter on its back, the Ju 88's tyres, certificated for a gross weight of 26,500 lbs., often blew out, causing many accidents. The gross weight of the composite aircraft, meanwhile, was probably about 44,000 lbs. Attempts were made to overcome this, on the one hand by reinforcing the tyres accordingly, on the other by fixing a jettisonable third shock strut beneath the Ju 88's fuselage. Neither of these solutions, it seems, was very satisfactory. Under no circumstances could the "Mistel" land as such, with the result that the unmanned bomber was lost in each sortie, regardless of whether the target was attained.

A squadron of Ju 88/Me 109 "Mistel" composite aircraft ready for action at an air base in Northern Europe. Cruising speed was about 210 m.p.h. and top speed around 350 m.p.h.

For pilot instruction purposes, a few trainer versions were built, consisting of a normal Ju 88 with cockpit and an Me 109 or Fw 190 fighter. A second pilot flew in the Ju 88; his job was to correct the take-off and land the lower component after the two aircraft had separated.

Hitherto, our description has been strictly historical. The lack of interim designs must strike the reader: nowadays, an attack at only 350 m.p.h. would be unthinkable; a precious all-metal aircraft with equally valuable engines and full equipment is expended for each operation. Does this mean that the basic idea was completely abandoned? A glance at the projects formulated at the end of the war, for improving this weapon, tend to give the opposite idea.

In 1944/45 the Junkers concern tried out a jet version of the "Mistel." This consisted of a Ju 287 jet bomber with forward-swept wing (powered with four or six Junkers or Heinkel-Hirth turbo-jets of 2,000 to 2,900 lbs. static thrust) and an Me 262 single-seat fighter (fitted with two Junkers jet units), and gave to expect speeds around the 500 m.p.h. mark. But the firm was also working on another project, aiming at the lowest possible manufacturing costs: a twin-engined Ju 268 aircraft carrying a Heinkel He 162 single-jet fighter (B.M.W. 003 E of approximately 2,900 lbs. static thrust). The Ju 268 was projected as a mid-wing monoplane of *wooden* construction, with twin fin and rudder unit, two turbo-jets of the same type as the fighter, and a jettisonable tricycle undercarriage. A speed of 500 m.p.h. was likewise expected of this composite design. In order to assure high accuracy of aiming, there was to have been a homing device working on a television principle.

It is not without interest to note that the majority of Junkers projects and design data, as well as many operational aircraft such as the Ju 287, Me 262 and He 162, were part of the war booty of the Red Army.

The strong umbrellas of air power which the modern sea powers possess, are surely not without holes. What would happen if a dozen or so jet "Mistel" designs, with a strong fighter escort, attacked an aircraft carrier, battleship or heavy cruiser—not to speak of transport vessels— simultaneously from all sides of the compass, directed by television homers and heat-seekers with dead accuracy towards the target? And the cost of such a squadron of explosive carriers would probably amount to only a fraction of the military and effective value of one single aircraft carrier.

Jato Junior

Rocket boosters to assist take-offs are no longer a novelty, and even during the last war many a thankful pilot and his crew owed their lives to those extra H.P. enabling an obstacle and ensuing catastrophe to be avoided at the very last minute. Many sorties would not have been at all possible had it not been for those small, handy sources of energy enabling unbelievably highly-loaded aircraft to rise from tiny airfields or the decks of aircraft carriers.

But quite apart from such exceptional instances, the take-off rocket could also become an article of general utility in every phase of flying. Passenger airliners will probably never make regular use of these devices, but their availability might nevertheless decide the fate of an aircraft and its occupants in the event of an engine failure at the moment of taking off. And which private aviator who, for some reason or other has found himself pitifully suspended in the trees at the end of the—Oh ! so terribly short—runway, would not enthusiastically pay the expenses of a JATO rocket installation if only he could turn the clock back to before his mishap ?

It is a well-known fact that work on small JATO rockets for small aircraft has been proceeding for several years. Aerojet Engineering Corporation, the Californian firm which, under the guidance of the distinguished aerodynamicist Professor von Karman, built the take-off aids for America's military aircraft, has already put two such small rockets on the market—the JATO JUNIOR for personal aircraft and the JATO BABY for still lighter types.

Details of the composition of the solid propellant used, and of the dimensions and thrust data, are surely of less interest to private aviators than the two accompanying photos showing "Navions" taking off with and without rocket assistance. And that the pilot using the Jato Junior is not some break-neck test pilot, but Dan Kimball, who obtained his licence in 1917 and is Under-Secretary of the Navy, speaks for the new small rocket's reliability.

Official Bulletin of the F.A.I.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

The General Council of the F.A.I. convened in Paris on April 27th and 28th, 1949, on the premises of the Aero Club of France at 6, rue Galilée.

The main decisions taken are as follow : —

1. *Requests to Join the F.A.I.* — A Sub-Committee has been constituted ; its five Members, all Vice-Presidents of the F.A.I., represent the Aero Clubs of France, Great Britain, Holland, Switzerland and U.S.S.R. This Sub-Committee will convene on the first day of the General Conference in Cleveland, O. ; its task will be to examine requests for affiliation to the F.A.I. and to formulate opinions on such requests.

2. *1949 General Conference in Cleveland.* — As previously announced, this year's General Conference will be held in Cleveland, Ohio, from September 2nd to 9th. The aero clubs should let the F.A.I. General Secretariat know how many delegates they are sending and what means of transportation these intend using for travelling to the U.S.A.

3. *Gold Medal of the F.A.I.* — This, the highest distinction which the F.A.I. may confer, was not awarded during 1948. Normally it is awarded to "those who, during the preceding calendar year, by their actions, works, successes, initiative or devotion, have greatly contributed towards the progress and the development of aeronautics." It was unanimously decided to constitute an Extraordinary Committee of four Members, representing Belgium, France, Great Britain and Holland, which will meet shortly in Paris and designate a person upon whom the Medal may be conferred on the occasion of the Cleveland Conference.

4. *Lilienthal Medal.* — The same procedure as above will be followed in order to choose a recipient for the Lilienthal Medal.

5. *1949 Budget.* — The accounts submitted by the Treasurer General, Mr. Jaques Allez, have been unanimously approved.

6. *International Calendar of Air Events.* — The General Council advised the Touring and Sports Commissions, which are concerned with drawing up the Calendar, each year to set March 1st as the latest date for inscriptions. A fusion of the two categories of competition is also being considered.

7. *OSTIV (Organisation scientifique et technique internationale du Vol à Voile).* — The General Council requested that the OSTIV, on the occasion of its meeting from May 3rd to 7th, establish a report mentioning its plans for the future and the financial resources upon which it believes it can count.

8. *Establishment of an F.A.I. Regional Air Touring Section in Cairo.* — The relevant suggestions made by the Royal Aero Club of Egypt, and also the comments on the subject made by certain member clubs on the occasion of the General Council's meeting, will be distributed to all member aero clubs by the General Secretariat.

The Bureau will also prepare a temporary study with respect to an F.A.I. regional organisation.

9. *Customs Carnets — New Guarantee Conditions.* — The draft guarantee conditions, submitted by the Royal Aero Club of the United Kingdom, were approved by the General Council after they had been examined by a three-man committee (Captain K. J. G. Bartlett, President of the F.A.I. Touring Commission ; Colonel R. L. Preston, Director of the F.A.I. Private Flying Section ; and Mr. L. Couhé, Secretary of the F.A.I. Sports Commission).

The new conditions will come into force shortly.

10. *New F.A.I. Badge for Pilots.* — The General Council has transferred this to the Sports and Touring Commissions, with a note recommending the proposal made by the Aero Club of France.

11. *Agreement between the F.A.I., the Fédération Internationale de l'Automobile, and the Fédération des Clubs Motocyclistes ; on Sports Penalties.* — The General Council has ratified the text of the agreement, which must now be signed by the Presidents of the three associations.

12. *Future F.A.I. Conferences.* — The Royal Aero Club of Sweden has invited the F.A.I. to hold its 1950 General Conference in Sweden around the month of June. For 1951, the Royal Aero Club of Belgium, which had already invited the F.A.I. to take part in its 50th anniversary celebrations, has extended an invitation to hold the 1951 General Conference in Brussels.

13. *Aero-Medical Commission — Diploma for Air Nurses.* — The General Council is of the opinion that the F.A.I. Aero-Medical Commission should be re-established as quickly as possible. The question of a diploma for air nurses will be examined as soon as the Commission has been formed.

Book Reviews

Thermopropulsion des Avions Turbines à Gaz et Compresseurs axiaux. By René Bidard. — Gauthier-Villars, Paris, 1949.

The author, who is a professor at the French *Ecole Nationale Supérieure d'Aéronautique*, has aimed to group the theoretical fundamentals of designing and calculating gas turbines and axial-flow compressors for the benefit of a wide section of the engineering profession. The result is a book printed in manuscript form, which is based on his lectures and is therefore sharply divided into the appropriate chapters.

Professor Bidard first mentions the aerodynamic and thermodynamic conditions attached to aircraft power plants, and follows with an examination of the structure and data relative to numerous turbo-jets and propeller-turbines. Then come descriptions of the circulation processes and the fundamentals of blade construction for turbines and compressors, with the accent on axial-flow designs. Analyses of combustion and, finally, of regulation and governing systems form the conclusion to this informative work. (French.) *Ri.*

Le Siècle de l'Avion. By C. H. de Levis Mirepoix and H. Beaubois ; foreword by Louis Bréguet. — Collection "Savoir" published by Librairie Arthème Fayard, Paris, 1949.

Is it still possible today, when aeronautics takes its roots in so many fields of knowledge and embraces such a wide domain of human activity, to deal with it comprehensively in one single, modest-sized book, without omitting or only superficially treating any of its manifold branches ? We would not have thought so. But the two authors have indeed succeeded in bringing, into 475 pages, so to speak all the facts and ramifications which could interest a wide circle of readers ; and not through tedious tabulation, but with lively descriptions of a well-thought-out series of domains, in a manner of which only real experts on the subject would be capable. A few of the twenty-eight chapter headings serve to give an idea of the great amount of material contained in this small encyclopaedia : "Erstwhile ideas on flying" — "What is the future of air forces ?"—"The aviator's physiology"—"The aircraft industry" (at last a non-technical description of an aircraft's evolution from the preliminary design stage to its entry into service)—"Air transport economics"—"Airports"—"A little politics and law." Other chapters deal with aeronautical history, the manner of function, piloting, applications and different constructions of aircraft—terse, understandable, and easy to read. This is a book which one would like to recommend to many politicians who come into contact with aeronautics, and which one would also like to see translated into many languages. (French.) *T.*

The Month in Review

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AVIATION POLITICS

● Finland joined the International Civil Aviation Organisation as the 52nd member nation on April 29th.

● Civil aviation agreements between India and Great Britain and India and Australia may result from discussions being held in New Delhi.

● Negotiations for a civil aviation agreement between Argentina and Bolivia are to commence in Buenos Aires.

● A civil aviation agreement between Egypt and Holland is expected to result shortly.

FIRST FLIGHTS

● The Republic XF-91 experimental aircraft, powered with one General Electric J-47 turbo-jet and four rocket motors, has successfully completed its first test flight at Muroc Air Force Base in California. The rocket units were not operated during this test flight, but in conjunction with the jet engine, they should enable the XF-91 to reach supersonic speed.

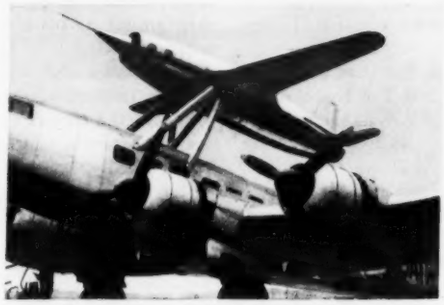
● The Vickers-Supermarine 510 experimental jet aircraft, which is the swept-back wing and tail version of the Vickers-Supermarine S.10/44 "Attacker" single-jet fighter, has made its first flight. Designed for high subsonic and for supersonic speeds, the aircraft possesses a span of 31 ft. 3 ½ in. and a length of 38 ft.

Vickers-Supermarine 510

● The SO M2 experimental single-seater jet aircraft, powered with a Rolls-Royce "Derwent 5," effected its first test flight at Orléans-Bricy on April 13th. It will be remembered that the SO M2 represents the flying model of the projected SO 4000 twin-jet bomber.

SO M2 of SNCA du Sud-Ouest

● The ramjet-powered Leduc 010 experimental aircraft made its first flight under its own power on April 21st. It was carried to an altitude of 16,400 ft. by a four-engined "Languedoc 161" and then released for a powered flight of twelve minutes' duration. At 11,500 ft. the engine was cut and the aircraft allowed to glide back to Toulouse Airport, whence it had taken off. The Leduc is a purely experimental aircraft, which is not meant to attain a high speed so much as to serve as a flying test bed for the ramjet unit. It is the first aircraft in the world to have flown with a ramjet as sole prime mover.



Leduc 010 ramjet research aircraft

● The NC 856 "Super Chardonneret," a three- to four-seater personal aircraft, has made its first flight at SNCA du Centre's factory airfield at Bourges. Derived from the NC 853 two-seater, it is powered with a Walter "Minor 4-III" engine of 105 H.P.

● The Boisavia B-60 "Mercurey" four-seater personal aircraft made its first flight on April 3rd and is being taken to the Brétigny test centre for further flight trials. The B-60 is a strut-braced high-wing monoplane of composite construction (ply-covered wooden wing, steel-tube fuselage) with single fin and rudder and a fixed tail-wheel undercarriage. The present power plant is a 140-H.P. Renault 4 Pei, but the aircraft will ultimately be powered with a 160-H.P. Continental or 190-H.P. Lycoming engine. The span is 37 ft. 4 in., length 20 ft. 3 ½ in., wing area 190 sq. ft., and gross weight 2,360 lbs.; maximum speed is 146 m.p.h., cruising speed 121 m.p.h., rate of climb 790 ft./min. and range over 620 miles. These performance data apply to the version powered with the Renault engine.

Boisavia B-60 "Mercurey"

NEW AIRCRAFT

● The first Lockheed F-94 two-seater jet fighter is scheduled for delivery to the USAF before the end of May, 1949. This aircraft is an all-weather night-fighter modification of the two-seater Lockheed TF-80C trainer, with radar equipment mounted in the nose.

● Flight tests are to commence shortly with the Bell X-2 experimental aircraft, a much larger and swept-back wing and tail version of the well-known Bell X-1 supersonic type. The X-2 is equipped with a Curtiss-Wright XLR-CW-1 rocket motor, whose thrust is said to be far higher than the 6,000 lbs. furnished by the Reaction Motors rocket unit powering the X-1. Stainless steel has been chosen to cover all surfaces and the cockpit is pressurised and refrigerated. It is expected that Mach numbers between 2.0 and 3.0 will be reached, which, at altitudes of over 35,000 ft., would correspond to speeds between 1,320 and 2,000 m.p.h.

● Following the investigation of considerable series of projects, a final design has now been selected for the Douglas X-3 experimental supersonic aircraft, and the company already has one such aircraft under construction at its Santa Monica plant.

● The second model of the two Northrop X-4 high-speed experimental aircraft on order for the U.S. Air Force has now been completed and will be transported to the Muroc base where the first model is now undergoing its test-flight programme.

● The production model of the Boeing B-47 "Stratojet" bomber will be equipped with six General Electric J-47 turbo-jets each furnishing over 6,000 lbs. thrust with water injection. Both XB-47 prototypes have Allison J-35 jet engines of 3,750 lbs. thrust.

● A new version of the Martin XB-48 bomber, equipped with four propeller-turbines instead of the usual six jet engines, has been proposed by The Glenn L. Martin Co. The U.S. Air Force has taken over the two XB-48 jet-powered prototypes and is continuing to test them. However, only the prototypes have been built so far, and no production order has yet been placed. To date there is no indication of whether or not the USAF is interested in the proposed propeller-turbine version.

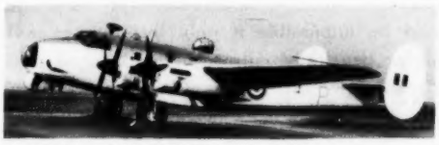
● Both Douglas Aircraft Co. and Lockheed Aircraft Corp. are said to be working on plans for a twin-jet airliner for inter-city operations. The aircraft would fly at 500 m.p.h. over stages of between 400 and 900 miles.

● Doman Helicopter Inc., of Danbury, Conn., announces the completion of the L-2A "Pelican," a new single-rotor utility helicopter with a conventional tail rotor for torque compensation. Power is furnished by a 245-H.P. Aircooled Motors Corp. engine placed in the nose of the fuselage at an angle of approximately 45 deg. to the rotor disc plane. There is accommodation for two pilots and five passengers in separate compartments. The gross weight is 3,200 lbs., the disc loading 2.0 lbs./sq.ft., and the power loading 13 lbs./H.P.; maximum speed is 85 m.p.h., hovering ceiling (without ground effect) 3,300 ft., service ceiling 14,000 ft., and range 225 miles. The same firm also announces that it has worked out plans for a long-range helicopter, to be known as the Doman HC-3. Of conventional layout with a single four-blade main rotor with foldable rotor blades, this helicopter is to be capable of being carried as a pod by the projected Fairchild XC-120 transport aircraft (twin tail-booms and central fuselage). In this way it is hoped to combine the high speed and long range of fixed-wing aircraft with the particular advantages of rotary-wing types, thereby opening up new vistas to helicopter utility.

● The Bellanca "Cruisemaster" is a new four-seater personal aircraft announced by Bellanca Aircraft Corp. of New Castle, Del. It is at present undergoing its C.A.A. type certification tests.

* Excerpts from Nos. 1684-1700 (19th April to 12th May, 1949) of "Interavia Air Letter," an aeronautical digest published five times weekly, with photo supplement, in separate English and French editions.

● The Avro GR.1 "Shackleton" long-range patrol bomber and reconnaissance aircraft is powered with four Rolls-Royce "Griffon 57" reciprocating engines of 2,450 H.P. take-off power driving pairs of contra-rotating three-bladed propellers. Equipped for all-weather operation with comprehensive radar and radio equipment (radar dome under the nose of the fuselage), the "Shackleton" is armed with two 20-mm forward-firing cannon mounted in remote-controlled turrets on either side of the fuselage nose, a dorsal gun turret containing another two 20-mm. cannon, and two 0.5-in. machine guns in a tail turret ; the bomb load is carried in a single bomb bay. The aircraft has a span of 120 ft., a length of 77 ft. 6 in., and measures 17 ft. 6 in. in height.



Avro GR. 1 "Shackleton"

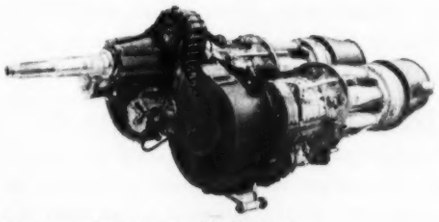
● A larger version of the Armstrong-Whitworth A.W.55 "Apollo" four-engined airliner, with a longer fuselage and accommodation for up to 45 passengers, is being studied. The larger "Apollo" would have an estimated payload increase of 2,500 lbs., thus bringing the total payload up to 10,000 lbs.

● Arsenal de l'Aéronautique is at present conducting tests with a remote-controlled target aircraft, the ARS 5501. Power plant is a pulse-jet engine, on which no further information is disclosed. The target aircraft was launched from a LEO 45 aircraft on April 2nd, but with its pulse-jet inoperative.

● Skandinavisk Aero Industri A/S, of Copenhagen-Kastrup, is to produce a small number of aerobatic aircraft designed by Engineer K. G. Zeuthen ; the prototype should be ready this summer. Except for the fabric-covered control surfaces, it is built entirely of wood. The plywood fuselage consists of a front portion integral with the wing, and a rear portion of elliptical section. The plexiglas cockpit canopy can be jettisoned. The wing has a single longeron and a torsion-resisting nose ; split flaps. Fixed cantilever undercarriage. Powered with a de Havilland "Gipsy Major 10" of 145 H.P., the aircraft is expected to attain, at a gross weight of 1,260 lbs. for aerobatics and of 1,433 lbs. for normal flight, a maximum speed of 180 m.p.h. and a cruising speed of 162 m.p.h. The range with normal fuel supply is estimated at 365 miles, and it should be possible to fly 725 miles with extra fuel tanks.

POWER PLANTS

● The Pratt & Whitney Aircraft Division of United Aircraft Corp. is developing the J-48 turbo-jet, a more powerful type than the J-42 (U.S.-built "Nene"). The J-48 is the U.S. version of the Rolls-Royce "Tay" axial-flow turbo-jet, and is intended for powering the Grumman F9F "Panther" fighter.



Armstrong-Siddeley "Double Mamba"

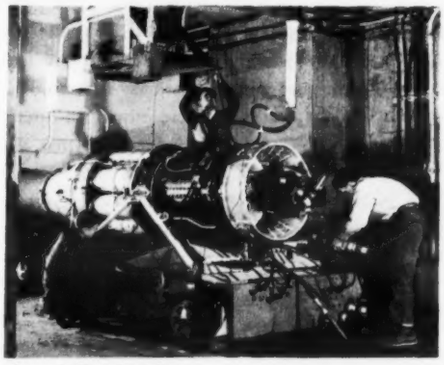
● The Armstrong-Siddeley "Double Mamba" propeller-turbine is basically a combination of two "Mamba" units, giving a total 3,500 shaft H.P. maximum combat power and 280 lbs. residual thrust at 400 m.p.h.

● Ranger Aircraft Engine Division of Fairchild Engine & Airplane Corp. has started first deliveries to the U.S. Navy of a new expendable turbo-jet engine known as the J-44. Other than that this engine is to be used as a power plant for guided missiles or drone aircraft, no further information has been disclosed.

● The Armstrong-Siddeley "Mamba 2," a more powerful version of the "Mamba 1," is now rated at over 1,270 shaft horsepower. An even more powerful version, to be known as the "Mamba 3," has been announced by Armstrong-Siddeley.

● Some details of two new models of the Rolls-Royce "Nene" jet engine are now available. The first is the Rolls-Royce "Nene 3," which was specially developed to be used in the Vickers-Supermarine S.10/44 "Attacker" fighter now in production for the Royal Navy. The "Nene 3" is a lighter version of the "Nene 2" and develops a static thrust of 5,000 lbs. at sea level. The second of the two new engines is the Rolls-Royce "Nene RN. 3," developing a static thrust at sea level of 5,500 lbs. with water-methanol injection.

● A SNECMA 14 U air-cooled 14-cylinder twin-row radial delivered 2,200 H.P. during a recent test run. The highest previously recorded output of the SNECMA 14 U was 2,000 H.P. at 2,500 r.p.m.



General Electric J-47

● The J-47 turbo-jet engine, which furnishes over 5,000 lbs. thrust, is now in production at General Electric Co., Inc.

INDUSTRIAL NEWS

● The tenth Flying Display and Exhibition of the Society of British Aircraft Constructors (S.B.A.C.) will be held at Farnborough on September 7th-11th, 1949. The public will be admitted on the 10th and 11th.

● Fairey-Clyde Pty., Ltd., is to manufacture guided missiles and anti-aircraft rockets in Australia. Fairey Aviation Co., Ltd., British partner in the concern, has been active in the guided missile field for several years.

● The U.S. Air Force has ordered 39 more Consolidated Vultee B-36 long-range heavy bombers powered with six reciprocating and four turbo-jet engines. This brings the total number of B-36s on order or delivered to 169.

AIR TRANSPORTATION

● Pan American World Airways will introduce Boeing "Stratocruisers" on the New York—London service three times a week from June 2nd. The aircraft will call at Gander and make the entire flight in a lapsed time of 13 hours.

● British European Airways has started a triangular weekday domestic service in Western Germany, linking Hamburg, Dusseldorf and Frankfurt. On June 6th a five-times weekly London—Dusseldorf—Munich service was inaugurated.

● Det Danske Luftfartselskab, the Danish component of S.A.S., inaugurated a Copenhagen-Bluie West One (Greenland) service on May 2nd with Douglas DC-4s.

● Flugfélag Islands HF, the Icelandic carrier, opened a weekly Reykjavik—Prestwick—London summer service with Douglas DC-4s on May 1st

Douglas DC-4 of Flugfélag Islands H/F

● Swissair's fortnightly Zurich—Cairo—Basra and Geneva—Cairo—Basra services have been combined and are now operated as a weekly Zurich—Geneva—Cairo—Basra line.

● Linee Aeree Transcontinentali Italiane (LATI), the Italian State-owned airline, has obtained authorisation from the Italian Government to make a special flight over its projected route to Venezuela, which will precede the resumption of services to Brazil and Argentina. Alitalia, the Anglo-Italian carrier, has increased its Rome—Buenos Aires schedule to two flights weekly. The services are operated with Avro "Lancastrians" and are routed via Dakar, Natal and Rio de Janeiro, with a weekly call at Sao Paulo, Brazil, and Montevideo, Uruguay. Linee Aeree Italiane, the Italo—American company, has opened a weekly Rome—Munich non-stop service, and now flies the Rome—Athens—Lydda route twice weekly. L.A.I. has also started a weekday Rome—Palermo service, extended thrice weekly to Tunis and thrice weekly to Catania.

MISCELLANEOUS

● Compania Mixta de Aviacion Aeroposta Argentina, the Argentine domestic carrier, is reported to be considering purchasing ten or twelve SAAB-90 "Scandia" twin-engined transports at a cost of between Sw.Kr. 15,000,000 and 20,000,000. K.L.M. Royal Dutch Airlines has almost completed negotiations for the purchase of ten SAAB-90 "Scandias."

● South African Airways has ordered four Lockheed L-749 "Constellations" for delivery between April and August of next year.

● Misr Airlines, the Egyptian carrier, has changed its name to Misrair S.A.E. by decision of the company's Board of Directors.

● British European Airways is at present operating 37 Vickers "Viking Mk. IIB," 23 Douglas DC-3, and 18 de Havilland "Dragon Rapide" passenger aircraft, with an additional four DC-3s used as freighters.

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Marginal Notes

Funeral sermon or prologue ?

The somewhat premature celebrations marking the end of the "not-so-dead" Berlin Airlift transpired with all due pomp on May 12th and 13th, 1949.

The Berlin city council decided to christen a square near Tempelhof *Platz der Luftbrücke*—Airlift Square. Illustrated magazines showed the first goods trains being unloaded and the jubilation of Berlin's children when they saw oranges for the first time. However, the "Summary of the Berlin Airlift" released on May 13th by the Office of Public Information of the U.S. National Military Establishment, which contains complete statistics on the entire eleven months of operations, starts off on a rather less jubilant note : "At present, it is not known exactly how much longer the air supply of Berlin will continue. However, the air-sea-ground teamwork of the services will remain available on the project as long as their presence is required."

And by the end of May the situation was the same as on June 21st, 1948, when Russia's blockade of Berlin's highways and railroads caused the Western Allies to launch "Operation Vittles."

Such "setbacks" are in no way astonishing. By its nature the Airlift cannot bring out any decisions but only a gaining of time for decisive negotiations or measures.

It would be wiser to expect final results from the Airlift only in limited fields. And in this respect it has surpassed its believers' highest hopes.

The statistics contained in the afore-mentioned release give unambiguous indications in this respect. Out of a total 195,998 flights (132,738 by the Americans and 63,260 by the British), some 380 aircraft (230 American and 150 British) carried 1,442,030 tons of cargo and passengers in eleven months. In other words, over one tenth of the world's airline tonnage (not counting Russia) must be ascribed to the Airlift. From the weight standpoint, twice as much was carried in a short year than during the three years of the Allies' wartime India—China "Hump" airlift (668,027 tons).

Still more impressive : Up to the end of April, 1949, a total of 48,365 GCA landings were made at the various Airlift bases ; 21,200 were made at Tempelhof alone. Aircraft were sometimes brought in at two minute intervals with the ceiling down to 500 feet and the limit of visibility one mile. Fatal crashes were limited to 29 American and seven British aircraft, compared to the wartime "Hump" operation which cost the Allies 468 aircraft.

The Berlin Airlift led up to a decisive re-occupation of Allied air force appointments. It helped to win over public opinion in Germany and to bring the Germans into step with Western politics. The Airlift gained time for the Atlantic Pact to be concluded and for the Marshall Plan to start rolling. The Airlift enabled aggressive negotiations to be circumvented, which would have been unavoidable without it, had it been necessary to hold the Berlin position despite the Russian blockade.

It would be regrettable if too much were now expected of the Airlift ; if the Western politicians and diplomats sat back and expected the Airlift to do the work that they themselves ought to do.

If certain U.S. Senators needlessly postpone for weeks the ratification of the Atlantic Pact because they regard the Taft-Hartley legislation as more important than maintaining world peace, then they should take good note of one point : the Airlift enables time to be gained, but not without limit.

ICAO—Joint Support

Railway transport would be impossible if only locomotives and coaches were available, but no developed railroad network. And civil aviation ? It is all too easily forgotten that aircraft alone cannot provide airline services ; at least not the type of services which the travelling public demands nowadays. Crews and the personnel in direct contact with airline operations represent but a very small fraction of the organisation of the world's civil air transport system.

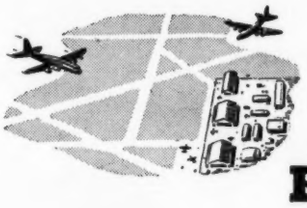
The actual aircraft may differ from one another, but their radio and navigational equipment have to work according to international standards, and the crews must be able to rely on finding as near as possible the same ground service procedures in all countries. It is safe to say that no other medium of transport calls for such far-reaching international co-operation as civil aviation does. Today we are still very far from that ideal situation—which could certainly be achieved only by a single international planning and operating agency.

Such considerations—which are by no means new—formed the basis of the recent ICAO conferences in London on the Joint Financing and Operation of Air Navigation Services, more commonly referred to as "Joint Support." The International Civil Aviation Organisation has frequently been named as an example of a successful international body whose members, by easily coming to terms with one another, have achieved practical co-operation. But with the best will in the world it is not possible to achieve the results we all hoped for—good will alone has no purchasing power. Thus, for example, the number of weather ships stationed in the North Atlantic has to be reduced from thirteen to ten—although not a single one of the ICAO delegates could have helped thinking of the two "Tudor" airliners which disappeared without trace not so long ago on the South Atlantic route, and of the scanty information available on upper-level weather conditions in the southern region of the North Atlantic airspace.

How, under such circumstances, could the Joint Support protagonists be in a position to fulfil Greece's request for funds to rehabilitate Ellinikon airport at Athens and improve the ground services and other aerodromes in Greece ?

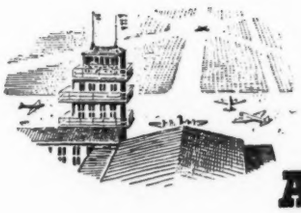
Once again the London conferences of ICAO revealed how closely associated the economic aspects of air transport are with those of aerodromes and navigational services. Airline operators will have to contribute more and more towards financing the ground services, for the governments—who have to shoulder the steadily increasing costs incurred by remote regions or a no-man's-land such as the North Atlantic—could one day decide that at least the national airports and navigational points should stand on their own feet.

As a matter of fact the airline passenger may not care at all whether the government subsidizes the ground services direct or through the medium of the airline companies. ICAO, however, might then find itself one day faced with the question of whether the available means would not justify the foundation of an operating agency outside state jurisdiction, to organise ground and navigational services for the world's civil air transport system.



Radiobeacons

Direction Finders



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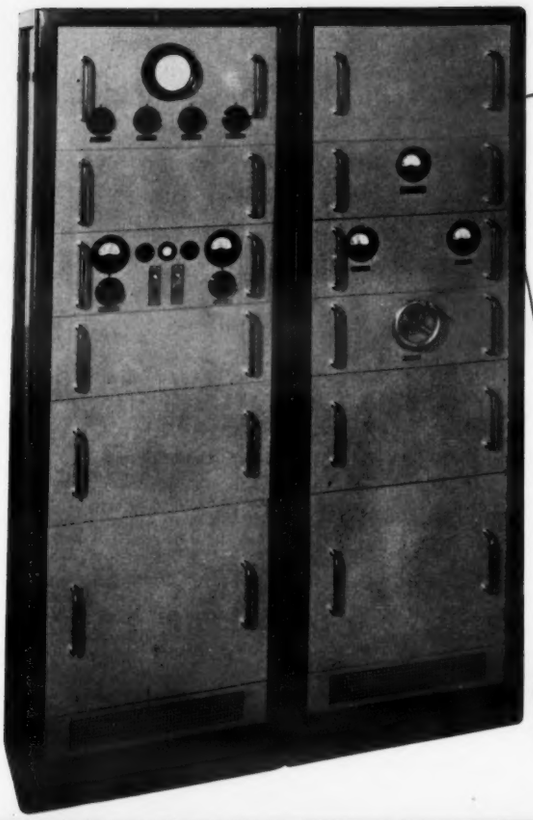

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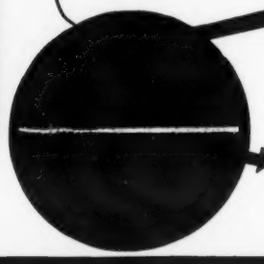

In the majority of RADARS, moving target echoes disappear in the ground clutter caused by neighbouring objects such as hills.

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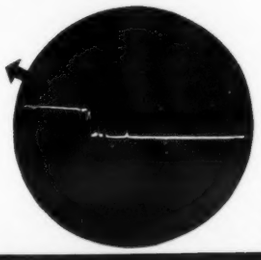

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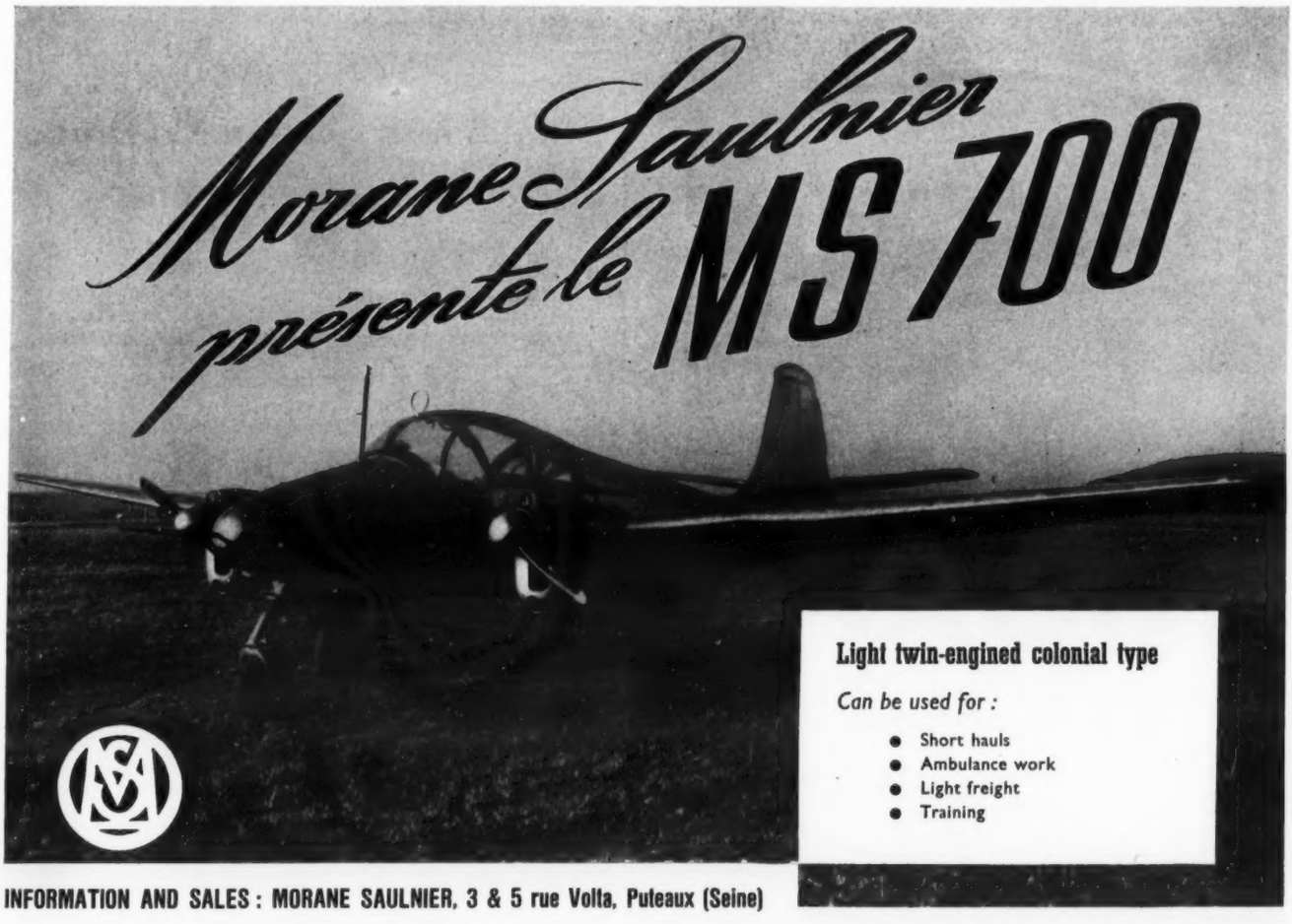

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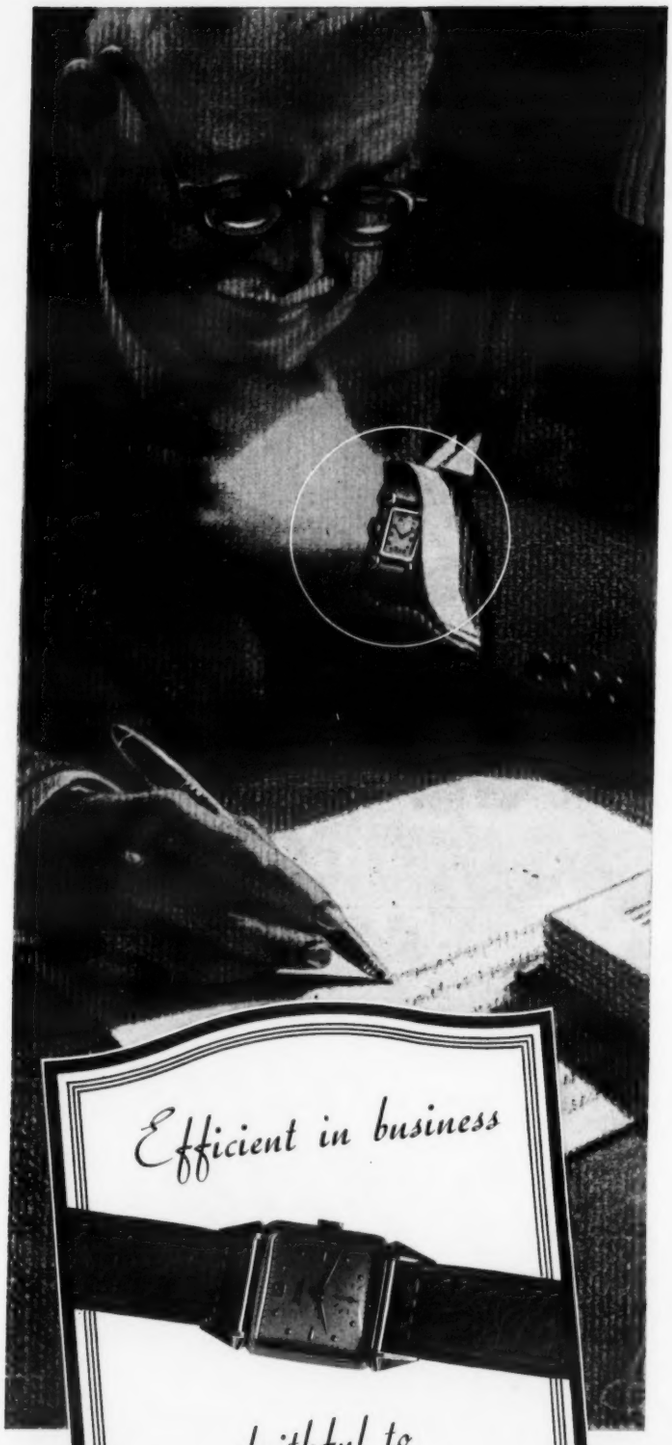

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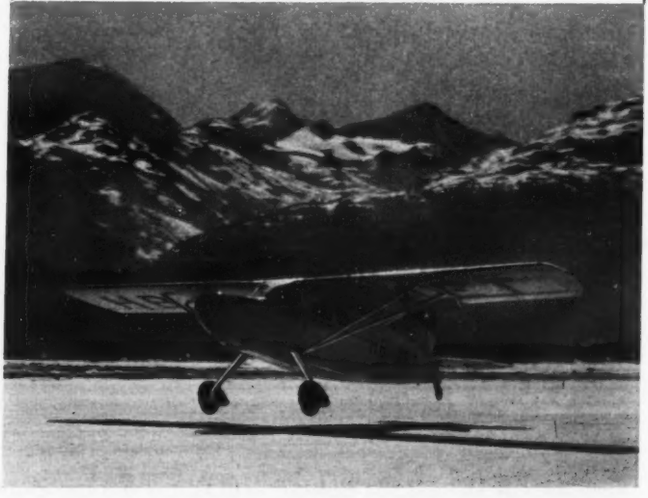

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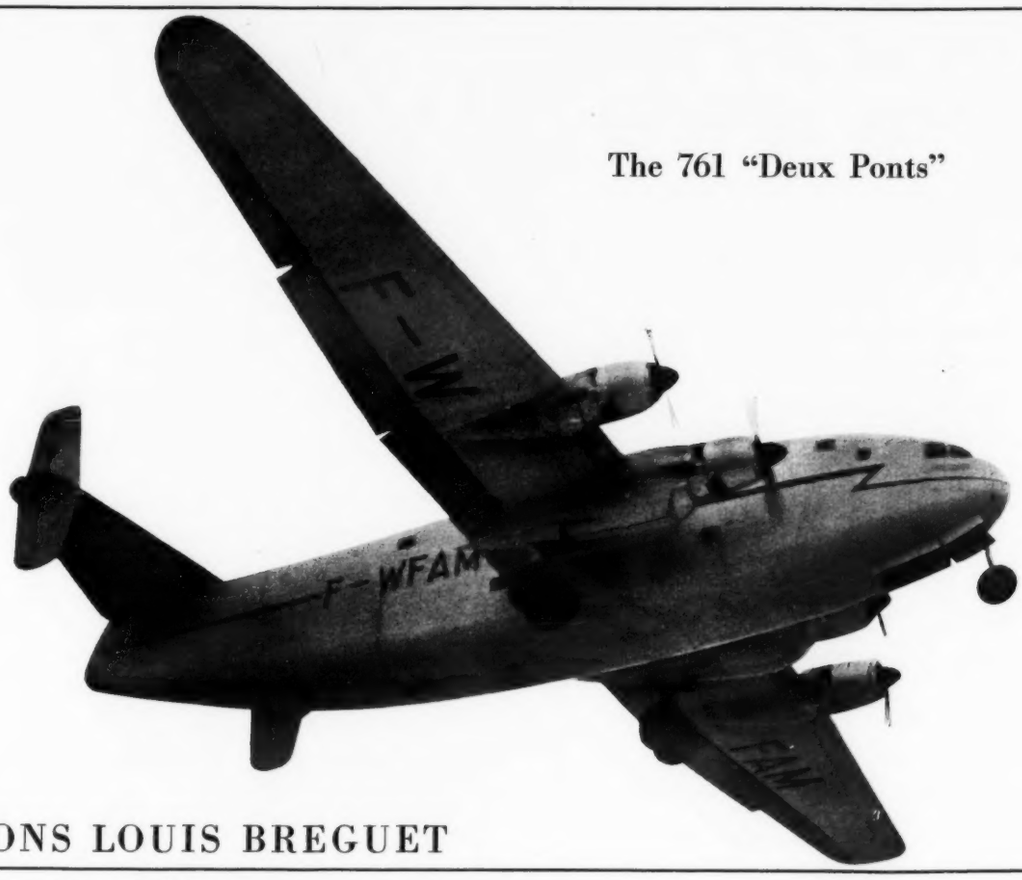

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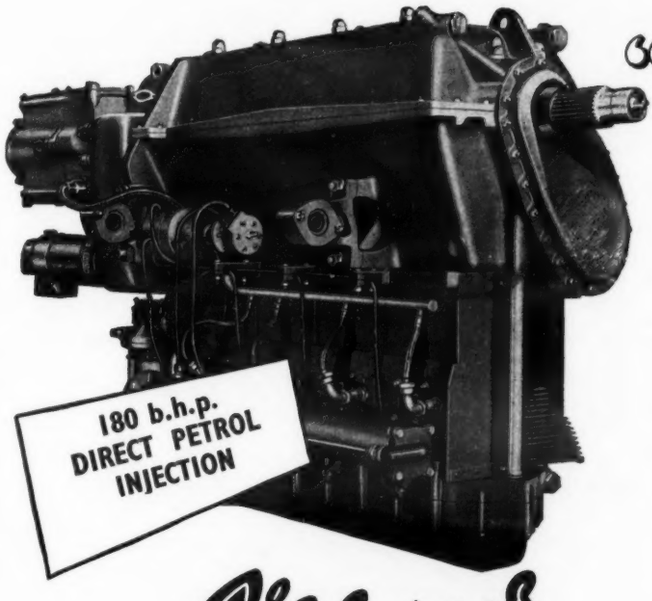

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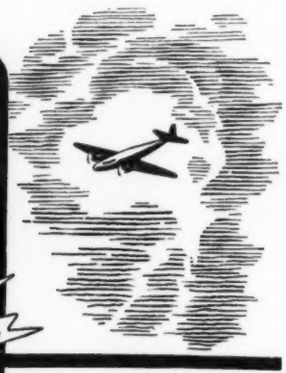

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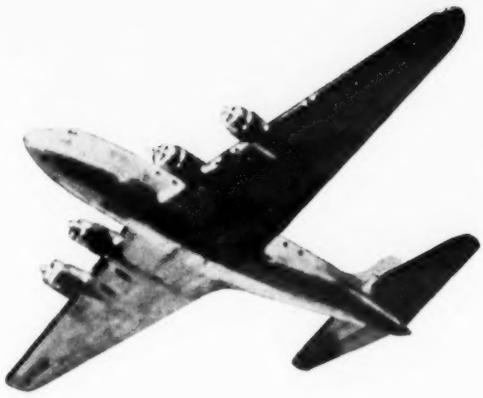

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